R
E.S.A.
V.S.A. 146

Mosquito News

Published Quarterly
by the
AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

VOLUME 15 DECEMBER, 1955 NUMBER 4

CONTENTS

ARTICLES PAGE

An Air Propelled Boat Used in Mosquito Abatement Work in Utah
Don M. Rees and Glen C. Collett 193

Review of Recent Progress in Mosquito Studies in Canada.....C. R. Twinn 195

Tests with Granulated and Systemic Insecticides Against *Mansonia* Larvae
H. C. Chapman 204

Maxillary Index and Biological Races in *Anopheles gambiae* Giles
Jean W. Fox and Richard M. Fox 207

Methods for Dissecting Salivary Glands in Mosquito Larvae and Pupae
Dinniemaud V. Jensen 215

Report of the Initial Operation of a Mosquito Light Trap in Northern Thailand.....D. C. Thurman, Jr. and E. B. Thurman 218

Oviposition Site Preference of *Aedes* Mosquitoes (Culicidae) in the Laboratory.....W. E. Beckel 224

Preparation of the Chorion of Eggs of Aedine Mosquitoes for Microscopy
George B. Craig, Jr. 228

Notes on the Influence of Salt-Marsh Topography on Tidal Action
W. D. Bidlingmayer and J. W. Klock 231

The Discovery of *Culex erythrothorax* Dyar in Texas
G. C. Menzies, R. B. Eads and F. C. Harmston 235

ASSOCIATION NEWS..... 237

Tentative Schedule of Annual Meeting..... 237

Partial List of Papers to be Presented at Annual Meeting..... 239

NEWS AND NOTES..... 241

REVIEWS AND ABSTRACTS..... 246

BIBLIOGRAPHY..... 250

LIST OF ADVERTISERS..... XV

ADVERTISING RATES..... XV

12th Annual Meeting of the American Mosquito Control Association, Beaumont, Texas, February 5–8, 1956.

MOSQUITO NEWS

Official Publication of the American Mosquito Control Association, Inc.

Editorial Office, State Education Building, Albany, N. Y.

D. L. Collins, Editor R. D. Glasgow, Consulting Editor

Margaret G. Slater, Assistant to the Editor

C. R. Twinn, Chairman, Publication Committee, 370 Science Service Bldg., Ottawa, Canada

Associate Editors

Helen Sollers (Bibliography), Plant Pest Control Branch, A.R.S., Washington 25, D. C.

Mrs. Helen Louise Durkee (Reviews and Abstracts), 113 Sonora Ave., Danville, Calif.

Austin W. Morrill, Jr. (News and Notes; Index), Sanit. Engr. Br., Ft. Belvoir, Va.

B. V. Travis (Articles), Cornell University, Ithaca, N. Y.

F. P. Creadon, Advertising Manager, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.

T. G. Raley, Executive Secretary, P. O. Box 278, Selma, Calif.

L. W. Smith, Treasurer, Parsonage Road, Metuchen, N. J.

William M. Thom, Asst. Treasurer, Parsonage Road, Metuchen, N. J.

Published by

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by

Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public health service.

SUBSCRIPTION RATES

$5.00 per Year (U. S. money), Single Copies, $1.75
Mailed without charge to members of the Association.

MEMBERSHIP DUES—$5.00

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in Mosquito News should be addressed to Donald L. Collins, Editor, Mosquito News, New York State Museum, Albany, New York.

F. P. Creadon, Advertising Manager, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.

Communications relating to subscriptions to Mosquito News, Membership in the American Mosquito Control Association, and other association matters should be addressed to T. G. Raley, Executive Secretary, American Mosquito Control Association, P. O. Box 278, Selma, Calif. Changes of address should reach the Secretary before the first of the month of publication.

Copyright 1955 by

The American Mosquito Control Association, Inc.

ARTICLES

AN AIR PROPELLED BOAT USED IN MOSQUITO ABATEMENT WORK IN UTAH

DON M. REES AND GLEN C. COLLETT
University of Utah, Salt Lake City, Utah

The extensive fresh and brackish water marshes near the shores of the Great Salt Lake in Utah are prolific mosquito producers. These marshes are difficult to inspect for mosquito breeding because they are usually inaccessible to motor travel and their immense size with the deep mud makes it impractical to attempt to inspect them on foot.

The marshes are created by drainage water meandering over an almost level plain produced by the receding waters of the Great Salt Lake. Many are temporary and their location and size vary with the season depending upon the fluctuation in the amount and place where the drainage water enters the marshes. Only a few roads enter the marshes and some of these are impassable, even to four wheel drive equipment, after storms or extensive flooding from irrigation drainage water. The water is usually too shallow in the temporary marshes and too covered with vegetation in the more permanent channels to permit the use of crafts with water propellers.

The large open marshes can readily be treated with insecticides by airplane but as larval production is constantly shifting in location and numbers it is necessary to determine from the ground the area to be treated before treatment can be economically made by airplane.

In 1954 the Box Elder County Fly and Mosquito Abatement District constructed and used an air propelled boat for mosquito abatement purposes on the extensive Bear River marshes in that district. The Salt Lake City and Davis County mosquito abatement districts jointly rented an air propelled boat in 1954 to inspect marshes in these districts. As a result of this experiment the Board of Trustees of the Salt Lake City Mosquito Abatement District decided to purchase an air propelled boat.

These boats are not new in Utah as they have been in use for many years by scientists and sportsmen concerned with the study, management or hunting of waterfowl. The first published account of these craft was made by Williams and Jensen in 1945 who reported on their use in waterfowl management and research. Since then certain improvements have been made which now make these boats practical and efficient for inspecting extensive shallow mosquito producing marshes. The craft herein described was assembled during the winter for use during the 1955 season. In addition to inspection, it can be effectively used for carrying light larviciding equipment and larvicides in granular or liquid form which can be transported as concentrates and diluted in the field for use on small mosquito producing areas or to clean up after airplane treatment of larger areas.

The boat selected (Fig. 1) was made by the Anchor Boat and Steel Company, a company with headquarters in Salt Lake City. The boat shown in the accompanying illustration is made of aluminum and is 16 feet long and 6 feet wide. The bottom is of .091 inch aluminum and the sides of .064 inch aluminum. The motor is a rebuilt 85 h.p. Continental Airplane motor with a 70 inch special prop made for this purpose by Banks and Maxwell at Fort Worth, Texas. The trailer was

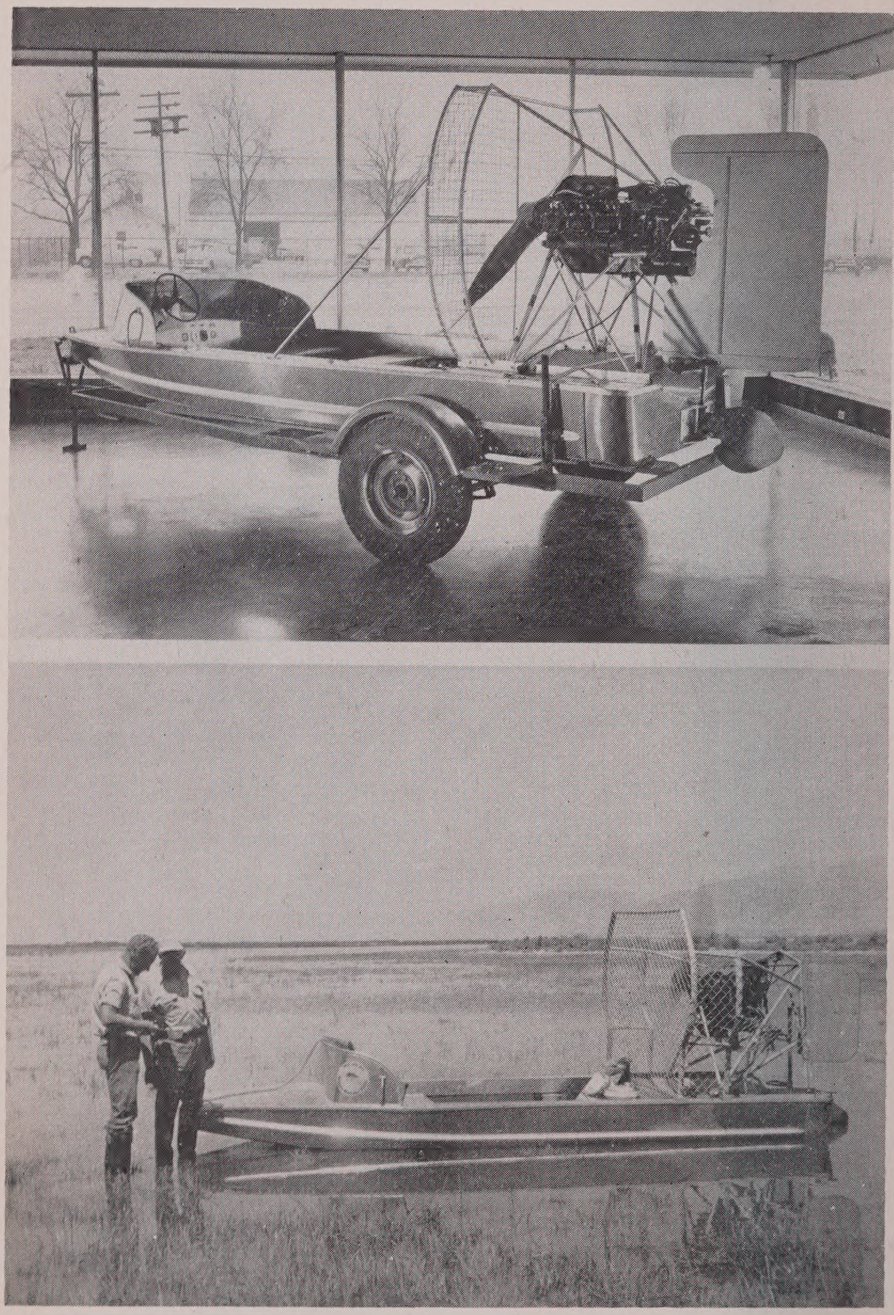


FIG. 1. Two views of the Utah air-propelled mosquito abatement boat.

constructed by the Anchor Boat Company. The boat, motor and trailer complete cost approximately two thousand dollars.

The boat can be operated in the field by one man. It will carry several men and their equipment over marshes, meadows and mud flats covered with but a few inches of water or in deeper open water covered with aquatic plants. The boat is capable of speeds up to 35 miles an hour in all types of environment from wet mud slick to deep water. At slow speed in deep water the draught is approximately 3 inches whereas at high speeds the boat planes. The only undesirable features detected to date in this equipment are the difficulties experienced in steering the craft in high cross winds and the overheating of the air cooled motor after prolonged runs at higher speeds. These are obviously only minor difficulties but should be considered along with the advantages made possible by using an air propelled boat.

The use of an air propelled boat in Utah has made it possible to inspect repeatedly and with ease during 1955 areas on marshes and mud flats that were previously inaccessible (Fig. 1). Boats of this type have apparently become standard equipment for certain districts in Utah and will take the place of motor vehicles previously used, often unsuccessfully, in attempts to reach the prolific mosquito producing areas near the shores of the Great Salt Lake.

Reference Cited

WILLIAMS, C. S. and JENSEN, G. H. 1945. A versatile boat for waterfowl management and research. Jour. of Wildlife Management Vol. 9, No. 3, July, pp. 191–192.

REVIEW OF RECENT PROGRESS IN MOSQUITO STUDIES IN CANADA [1]

C. R. TWINN [2]

INTRODUCTION. During the past eight years considerable attention has been given to the study of mosquitoes and other biting flies in Canada. Much of this work has been performed on behalf of the Defence Research Board, Canada Department of National Defence, but recently the needs of the pulp and paper industry have also been given special attention. Many of the results have general application. Numerous papers based on these studies have been published since 1948; summarizing statements and references have been presented by Twinn (1950, 1952, and in press) and Freeman (in press).

This paper reports progress in the studies relating especially to mosquitoes and includes references to recently published and some unpublished work.

SYSTEMATICS AND DISTRIBUTION. In a review of some of the more important mosquito problems in Canada, Twinn (1949) presented a summary of the recorded distribution in Canada of 59 species of mosquitoes belonging to eight genera. Since then, several additional species (*Aedes hexodontus* Dyar, *A. implicatus* Vock. (=*A. impiger* of American authors), *A. rempeli* Vock., *A. pseudodiantaeus* Smith) have been found and many new distribution records obtained. This is largely the result of the Northern Insect Survey, carried out during the summer seasons of the past eight years by the Systematic Entomology Unit, Entomology

[1] Contribution No. 3307, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.

[2] Head, Veterinary and Medical Entomology Unit.

Division, Ottawa, on behalf of the Defence Research Board. Specimens of biting flies and of many other insect groups were obtained from more than 50 Arctic and Subarctic localities.

An interim report on the distribution of the mosquitoes obtained in the Survey was prepared by Freeman (1952). In a brief account of the Survey, Freeman (in press) stated that data from these northern areas indicate that emergence of adult mosquitoes apparently commences about four weeks after the mean temperature for 14 days reaches 34° F., and that mosquitoes have not been found north of the July isotherm of 35° F.

Other useful sources of Canadian distribution records as well as of other biological information are papers by Haufe (1952), Curtis (1953), Twinn (1953), Rempel (1950, 1953), Judd (1954), and Vockeroth (1954b). Of the two papers by Rempel, one (1950) deals with the mosquito larvae of Western Canada and the other (1953) with the adult mosquitoes of Saskatchewan. Both contain keys to the genera and species and excellent illustrations of the taxonomic characters used in identification.

Other important contributions to the systematics of Canadian mosquitoes are contained in three papers by Vockeroth (1950, 1954a, 1954b). In the first he reports specific characters in the tarsal claws of some species of *Aedes;* in the second he describes two new species of this genus and clarifies the identities of certain others, and in the third includes a revised key to the females of northern species of *Aedes* and an outline of the distribution of each.

Beckel (1954a) discussed the difficulty of separating the females of the black-legged species complex within the *Aedes* genus in the Churchill region, and indicated the unreliability of the mesonotal colour pattern for this purpose. He suggested characters that may be used to separate all the species in the complex (except *A. punctor* (Kby.) from *A. hexodontus* Dyar, and *A. intrudens* Dyar from *communis* (Deg.)) and presented a key to the species based on these characters.

OTHER BIOLOGICAL STUDIES. 1. Laboratory Colonization. The study of mosquitoes and the development of more effective control and protective methods is facilitated if continuous laboratory colonies can be maintained. So far, it has not been possible to do this with northern species of *Aedes,* but the subject is receiving special study by Mr. W. E. Beckel, Defence Research Northern Laboratory, Fort Churchill, Man. The more important problems under investigation include breaking the diapause in the eggs and stimulating them to hatch whenever required, determining optimum conditions for rearing the larvae and pupae, and inducing the adults to mate and lay viable eggs in cages. Although success in colonizing any of these species has not yet been achieved, valuable progress toward this end has been made, and as the study involves an investigation of all stages of the life-cycles of the insects, it has produced much useful biological information (Beckel, 1953, 1954b).

2. Environment, Behavior, and Development. A study of the physical environment and behavior of the immature stages of *Aedes communis* (Deg.) made over a period of three years in selected pools in open subarctic forest at Churchill, Man., has been reported by Haufe (in preparation). He showed that behavior patterns of this species modify the effect of environmental conditions on rate of development, and that these behavior patterns are related to conditions in the pools caused by factors peculiar to far northern latitudes, such as the underlying permafrost and the low angle of inclination to the horizontal of the sun.

Haufe points out that the relations thus established between mosquito development and environmental conditions in this northern area are different from those reported from tropical areas. In the north the behavior of immature stages of mosquitoes is such that solar radiation has an important effect on the rate of development.

This is because mosquitoes in the north generally develop under suboptimum temerature conditions, and consequently the larvae and pupae insolate themselves at the surface of the pool to raise the body temperature above the ambient temperature; furthermore, peripheral insolation in the pools provides horizontal as well as vertical temperature gradients, which influence both the development and the behavior of the larvae and pupae.

From these observations on the behavior and development of *A. communis* and associated species, and mathematical descriptions derived for the relation between meteorological elements and the daily average temperature of mosquito pools, Haufe and Burgess (in press) suggested formulae for predicting mosquito emergence in a permafrost, forest-tundra transition area. They also stressed the need of further research to establish the applicability of these formulae to temperate regions and to areas of more varied topography than exist at Churchill. A summary of the principles involved has been published (Haufe, 1953).

3. Mosquito Behavior and Weather. Projects were also completed at Churchill on the relation between the activities of adult mosquitoes and meteorological conditions. The voluminous data from this three-year study are still being organized and statistically analyzed. Mr. W. O. Haufe, who was the leader in these projects and is now in charge of the Livestock Insect Section, Science Service Laboratory, Lethbridge, Alta., proposes to publish the results in a series of three papers under the general title "Mosquito Behavior and Weather": the first on the relations of macrometeorological factors to adult mosquito behavior, the second on relations of the ecoclimatic environment to mosquito activity, and the third on relations of mosquito activity to the human host under natural microclimatic conditions.

A related study on the vertical distribution of *Aedes* mosquitoes was started at Churchill in 1953 and continued at Rowanton Depot, Que., in 1954, to augment the data obtained at ground level. Knowledge on this subject is necessary for a more thorough understanding of mosquito behavior and to make possible more effective and economical use of insecticides in control operations. Sampling techniques have to be developed and the efficiency of sampling devices measured.

An index to mosquito flight activity at ground level was obtained by means of an hourly sampling, visual attraction trap. Essentially the trap consists of a revolving metal cylinder painted with alternating black and white stripes and suspended from a tripod. Statistical analysis of catches over a period of two or three years is required to determine its variability in efficiency of attraction. However, an assessment of the efficiency of this trap in comparison with a suction trap in the forest at Rowanton Depot, Que., in 1954, by Mr. L. Burgess (unpublished data) gave results indicating that the visual attraction trap does not give an accurate picture of the species composition or relative abundance of species in a mosquito population.

Methods of obtaining samples of mosquitoes at different altitudes tried at Churchill included the use of sweep nets on light aircraft, and attached to box kites towed behind a railway speeder on the Hudson Bay Railway. Neither method proved satisfactory. Perhaps electrically operated visual attraction traps placed on towers at various heights might be more effective.

The effect of atmospheric pressure on the flight activity of mosquitoes was also studied by Haufe (1954) in laboratory experiments at the University of Western Ontario, London, Ont., with *Aedes aegypti* (L.). Females with similar development histories, namely, those emerging from the same brood within 8-hour periods of relatively stable pressure, were used in all the experiments. He found that changes in atmospheric pressure are an important factor in determining flight activity, provided that the mosquitoes are first acclimated for 3 to 6 hours to a particular pressure level. When the pressure was above 735 mm., decreasing pres-

sure was more stimulating to flight than increasing pressure, whereas when it was below 735 mm. the opposite was obtained. At 500 to 550 mm. the effects of changing pressure were negligible.

4. Dispersal and Flight Range. In planning control measures, it is important to have knowledge of the dispersal habits and flight ranges of the various species. Toward this end, Shemanchuk *et al.* (1953), with prairie mosquitoes in Saskatchewan, developed an improved method of radioactive tagging. This consists of keeping fourth-instar larvae in a solution of 0.1 microcuries of radioactive phosphorus (P^{32}) per millilitre of water for 24 hr. at a density of one larva per millilitre and returning the larvae to their normal habitat to complete their development. In an experiment with *Aedes flavescens* (Muller), radioactive females were collected as far as 6.6 miles from the emergence site and males 1,400 yards (Shemanchuk *et al.*, 1955). However, the value of this method is limited, because the population of tagged mosquitoes is rapidly diluted as it moves away from the emergence site, so that collection of tagged specimens becomes progressively more difficult and uncertain the farther it is done from the site. To obtain evidence on the outer limits of flight range especially of prairie and tundra species requires the tagging of enormous numbers of larvae and the use of more efficient collecting and trapping methods than are at present available.

Hocking (1953) followed a different approach to the problem of flight range by studying the energy resources of some of the northern species at Churchill in relation to their power requirements and efficiency in utilizing energy in flight. By ingenious observations and experiments, he obtained data on which he based estimates of the maximum distances certain species might travel in still air and their possible maximum air speeds. He concluded that the northern biting flies, including mosquitoes, obtain their energy for flight from the nectar of flowers, and that peaks of nectar production on tundra and in forest coincide with the peaks of flight of tundra and forest mosquitoes. Significantly, the crops of female mosquitoes swarming were found to be full of nectar. He made the novel suggestion that if honey bees were introduced in adequate numbers in the Churchill region they would provide strong competition for the available supplies of nectar, and might thus restrict the flight range of migratory species of mosquitoes and greatly reduce the area it would be necessary to treat with an aerial spray to obtain local control.

Another approach to this problem has been followed by Mr. J. A. Downes, Veterinary and Medical Entomology Unit, Ottawa, in a project on the flight characteristics of *Aedes* mosquitoes in relation to swarming, distribution, and finding of hosts. Observations on the swarming habits of mosquitoes at Churchill in 1952 and 1953 indicate that the insects orient themselves upwind while in visual contact with the ground. During temperature inversions, they follow the warm air upward and, in treeless country, lose contact with the ground and move downwind. Convection currents may also carry them to a height where they lose visual contact with the ground and fly with the wind. This is a possible explanation of the mass movement of mosquitoes for long distances over prairie and tundra. Downes (1955) has reported the results of similar studies with biting midges (*Culicoides* spp.) that show many parallels with the mosquitoes.

Hocking (1953) summarized published information on the flight ranges of 41 species of mosquitoes. The farthest distance he recorded was about 110 miles by *Aedes sollicitans* (Wlk.) over the sea.

5. Food and Egg Development. Earlier studies in Canada to determine the foods of adult mosquitoes and other biting flies have been reviewed (Twinn, 1952). Mr. A. E. R. Downe, Veterinary and Medical Entomology Unit, Ottawa, is continuing work commenced at Queen's University, Kingston, Ont., by West and Eligh (1952) on the determination by

serological methods of the source and volume of blood meals of these insects. Specimens are trapped in barns and other buildings or netted in the field and those found to be engorged are smeared on filter paper or pinned with appropriate data and later subjected to the precipitin test, to determine upon which animal they have fed. The pinned specimens enable identifications to be made before the insects are destroyed in the tests.

Downes (in preparation) points out that there is a sexual difference in the food habits of biting flies in the families of Nematocera (mosquitoes, blackflies, punkies, moth flies) and lower Brachycera (horse flies, deer flies, snipe flies). Both sexes take carbohydrates, usually as nectar from flowers, for energy, but the females also take protein, as in blood meals, for use in egg production. He states that this generalization applies to all the families of biting flies in these groups, equally to the well-known forms such as mosquitoes and blackflies, which feed on the blood of vertebrates, and to the net-winged midges (Blepharoceridae) and many species of punkies, which obtain their protein from the blood of other insects, or, as in one species of the latter, from the contents of pollen grains of honeysuckle. In a few species the eggs are developed from reserves laid down in the larval stage and retained in the fat-body or muscles.

Hocking (1954) concluded from a study of field-collected females that the form of *A. communis* prevalent at Churchill, Man., utilizes the nitrogen from autolysis of the flight muscles in developing its eggs. Beckel (1954c), who found that *A. communis* at Churchill did not take or need a blood meal to develop eggs, reported that females reared in the laboratory from field-collected pupae developed and laid eggs on a diet of sucrose or raisins alone, without any indication of reduction or abnormality of the flight muscles. He suggested the fat-body and larval muscles in the adult as other possible sources of protein for egg development in this species.

6. Behavior in Relation to Hosts. Information on the behavior of mosquitoes in relation to their hosts is of value in developing methods of personal protection. During recent years, Brown (1952) and others have investigated the responses of female *Aedes* mosquitoes and published a series of papers on the results. The most recent paper (Smart and Brown, in press) reports the effects of skin temperature, hue, and moisture on the attractiveness of the human hand as demonstrated in laboratory experiments with *A. aegypti* at London, Ont. Dark skins were found to be more attractive than light skins: negroes more attractive than orientals, and both more attractive than caucasians; of the last, dark-skinned individuals were more attractive than light-skinned. With caucasian subjects, warm skins were more attractive than cool skins. Hands artificially cooled to 72 to 77° F. were only one-fourth as attractive as normal hands at 88 to 93° F. Hands of individuals with low moisture output were more attractive than those of high moisture output. Hands induced to perspire freely were less attractive than the normal hand. Laboratory tests were also made of the attractiveness of human sweat to *A. aegypti*. From these, Thompson and Brown (1955) concluded that sweat from the armpits of caucasian males was significantly attractive, but sweat from the foreheads was not.

In a recent paper Brown (1954a) reported on the attractiveness of colored cloths to species of *Aedes* in Canada. Eight dyed flannels, seven colored satins, and 17 other fabrics were tested. Their attractiveness varied inversely with their brightness or reflectivity of visible light in the wavelength range of 475 to 625 millimicrons; for color values of similar lightness or darkness, the order of attractiveness was black, red, blue, green, white, and yellow. Field tests at Goose Bay, Labrador, showed that the wearing of clothing unattractive to mosquitoes does not increase the number of attacks by the insects on the unprotected skin of the wearer (Brown, 1955).

Dr. A. A. Kingscote, Ontario Veterinary College, Guelph, Ont., is also carrying out

experiments to obtain information on factors that attract or repel mosquitoes. A completed investigation (Kingscote, 1954) indicated that the surface temperature of the host had a definite effect on the attractiveness of rats to *A. aegypti*. Age of the host in itself had a negligible effect, and weight had an inverse relation to the number of mosquitoes attracted. Atmospheric pressure influenced the number attracted under the conditions described.

BIOLOGICAL CONTROL. The role of parasites and predators in the natural control of mosquitoes and other biting flies is being studied by officers of the Entomology Laboratory, Belleville, Ont. (James, 1953).

The life-history of a nematode, *Limnomermis* sp., parasitic in larvae of *Aedes communis* (Deg.) was ascertained in general at Churchill, Man., and some data were obtained on the life-history of a protozoan, *Thelohania legeri,* also a parasite in the larvae of this species. James (in preparation) also studied a chaoborine predator, *Mochlonyx culiciformis* (Deg.), in woodland pools at Chatterton, Ont. He found that it has one generation a year and a life-history apparently similar to those of the *Aedes* species associated with it. Its larval food consisted mainly of small crustacea and it preyed on mosquito larvae only when these were smaller than itself. The role of other predators of mosquito larvae, including several species of aquatic beetles, is under study. Progress in the use of the precipitin test for determining predator-prey relationships has been reported by Hall *et al.* (1953) from studies carried out in the Department of Biology, Queen's University, Kingston, Ont.

Natural enemies are probably of prime importance in reducing mosquito populations, but much more needs to be known about them and their role in mosquito control before it would be practical to attempt to increase their effectiveness on a sufficiently large scale to be of value.

CHEMICAL CONTROL. 1. Control Work in Canada. Mosquito control work in Canada is generally carried out on a modest scale. The Royal Canadian Air Force and the Canadian Army provide protection for their larger military establishments and some of the smaller isolated ones by aerial spraying of surrounding areas of up to 10 sq. mi. or more with DDT larvicides and adulticides. These treatments are supplemented by conventional ground measures and methods of personal protection. Mosquito control is also practised in some of the national parks by the federal government to protect visitors. Many towns and smaller communities as well as the larger cities across Canada take local action against mosquitoes when these are troublesome in their environs, but annual expenditures rarely exceed a few thousand dollars in any one area.

An example is Winnipeg, where antimosquito work has been carried on since 1927, until recently with wholly inadequate funds. Of the approximately 23 species identified in the area, a number are typical prairie forms that may disperse considerable distances. Stansfield (1953) has given an interesting account of the development of the control work in this area since its inception. The situation at Winnipeg was much improved in 1954, when, on March 25, the Legislative Assembly of Manitoba passed "An Act to provide for the establishment, powers, and duties of the Greater Winnipeg Mosquito Abatement District," the first of its kind in Canada. One immediate benefit from this legislation was an increase in the annual appropriation for mosquito control from about $12,000 to nearly $35,000 that resulted from a levy of 10 cents per capita in Greater Winnipeg.

Experimental work in the chemical control of mosquitoes and other biting flies has been carried on by the Veterinary and Medical Entomology Unit, Ottawa, with the cooperation of the National Defence Department and other agencies, including, recently, the Pulp and Paper Research Institute of Canada (Peterson, 1955).

An account of the development of methods of controlling mosquitoes with insecticides and the testing of machines for applying them in Canada was presented by Brown (1954b). Control recommenda-

tions were described by Twinn and Peterson (1955).

Area control by applying DDT from aircraft is reasonably effective south of the tree line when properly applied over a sufficiently large area, the size of the area depending largely on local conditions, such as species, topography, and vegetation. It is not practicable on the tundra because the prevalent species of mosquitoes may travel long distances and quickly reinfest treated localities.

2. Resistance Studies. A year or two ago unsatisfactory results from the application of aerial sprays in southern Ontario were blamed on resistance of mosquitoes to DDT. However, standard laboratory tests of larvae and adults from various localities in the region indicated that there was no perceptible difference in susceptibility between mosquitoes from areas where DDT had been sprayed in previous years and those from unsprayed areas (Brown *et al.*, 1954).

3. Aerial Spraying. Much valuable work on the investigation and development of insecticide dispersal equipment on aircraft, the assessment of aerial sprays, and the development and testing of insecticide formulations has been carried out at the Defence Research Board's Suffield Experimental Station, Ralston, Alta., under the direction of Dr. H. Hurtig, of the Entomology Division, Canada Department of Agriculture. Hurtig (1953) has published a brief review of the development of the use of aircraft for applying insecticides, and has a complete review of the airspray work at Suffield in preparation.

During the past four years officers of the Veterinary and Medical Entomology Unit, Ottawa, have assessed the performances of a number of machines in producing aerosols and controlling adult mosquitoes. Five of these, namely, the Microsol, the Husman, the Bes-Kil, the TIFA, and the Dyna-Fog, with emission rates of 20 g.p.h. or more, were tested in 1951 and 1952, and the results published (Brown and Watson, 1953). Two portable generators with lower emission rates, namely, the Swingfog and the Dyna-Fog Jr., were tested in a similar manner in 1953 and 1954 (Brown and Morrison, 1955).

A portable mist sprayer operated on the pneumatic principle at a pressure of 10 p.s.i. has been designed at Kamloops, B. C., by Curtis (1954). It is power-driven by a light gasoline motor and air compressor, and equipped with a tank of 2 gal. (imp.) capacity. It weighs 40 lb. when empty and 58 lb. when fully loaded, and is intended for use in hilly and wooded areas where roads and trails passable to vehicles are lacking.

In July, 1954, Dr. A. W. A. Brown, University of Western Ontario, who has taken an active part in biting-fly investigations while in the seasonal employ of the Entomology Division, assisted in tests of various machines for applying adulticides in the San Joaquin Valley, California, carried out as a joint study of the California Mosquito Control Association and the California State Department of Health's Bureau of Vector Control. The results (Brown and Mulhern, 1954), although not conclusive, should lead to the more effective use of adulticides and encourage further studies of a similar nature.

Repellents. At the Ontario Veterinary College, Guelph, Ont., Kingscote (1952) demonstrated experimentally that laboratory animals developed no repellent action against *A. aegypti* from the internal administration of tolerable doses of known insect repellents, alcohols, aldehydes, ethers, esters, acids, amides, phenols, saturated aliphatic hydrocarbons, aromatic hydrocarbons, alkaloids, ketones, oleo resins, salts, volatile oils, vitamins, sex and other hormones, and body deodorants.

In studies of repellents at Toronto and Ottawa, Ont., there has been little progress beyond that reported by Roadhouse (1953) and Kasman *et al.* (1953). Existing techniques for the laboratory assessment of repellent compounds have proved unsatisfactory because of a high degree of variation in the results obtained, which makes them difficult to interpret. This is believed to be due to variation in (1)

the rates of absorption of the chemicals in different subjects, (2) in volatilization, and (3) in the responses of the test insects. Attempts are being made by Mr. D. G. Peterson, Veterinary and Medical Entomology Unit, Ottawa, to develop a more suitable technique for measuring quantitatively the inherent repellency of such compounds.

SUMMARY. Progress in studies on mosquitoes in a biting-fly research program in Canada is reviewed and references are given to recently published and some unpublished work. The subjects dealt with include systematics and distribution of Canadian species; attempts to rear laboratory colonies of northern species of *Aedes;* relation of the immature stages to their environment; behavior of adult mosquitoes in relation to meteorological conditions; their dispersal and flight range; food of the adults; responses of *Aedes* females to various factors relating to their hosts; biological and chemical control, and repellents.

References

BECKEL, W. E. 1953. Preliminary observation on a hatching stimulus for *Aedes* eggs (Culicidae). Science, 118:279–280.

BECKEL, W. E. 1954(a). The identification of adult female *Aedes* mosquitoes (Diptera:Culicidae) of the black-legged group taken in the field at Churchill, Manitoba. Canadian J. Zool., 32:324–330.

BECKEL, W. E. 1954(b). Studies of the biology of the *Aedes* of northern Canada. Parts I–IV. Canada Dept. Natl. Def., Def. Res. Bd., DRNL Tech. Papers Nos. 6–11.

BECKEL, W. E. 1954(c). The lack of autolysis of the flight muscles of *Aedes communis* (Degeer) in the laboratory. *Mosquito News,* 14:124–127.

BROWN, A. W. A. 1952. Factors in the attractiveness of bodies for mosquitoes. Trans. Ninth Intl. Congr. Ent., 1:895:900.

Brown, A. W. A. 1954a. Studies on the responses of the female *Aedes* mosquito. Part VI—The attractiveness of colored cloths to Canadian species. Bull. Ent. Research, 45:67–78.

Brown, A. W. A. 1954b. Chemical control of mosquitoes in Canada. Rend. ist. super. sanita. suppl., pp. 13–21.

BROWN, A. W. A. 1955. Effect of clothing color on mosquito attack on exposed skin. Jour. Econ. Ent. 48:130.

BROWN, A. W. A., ARMSTRONG, J. A., and PETERSON, D. G. 1954. Investigation of suspected resistance to DDT of mosquitoes in southern Ontario. *Mosquito News,* 14:192–194.

BROWN, A. W. A., and MORRISON, P. E. 1955. Studies on portable jet aerosol generators for control of adult mosquitoes. *Mosquito News,* 15:1–12.

BROWN, A. W. A., and MULHERN, T. D. 1954. A report on tests of the performance of adulticiding machines in California. *Mosquito News,* 14: 175–186.

BROWN, A. W. A., and WATSON, D. L. 1953. Studies on fine spray and aerosol machines for control of adult mosquitoes. *Mosquito News,* 13:81–95.

CURTIS, L. C. 1953. Observations on mosquitoes at Whitehorse, Yukon Territory (Culicidae: Diptera). Canadian Ent., 85:353–370.

CURTIS, L. C. 1954. A portable pneumatic spray unit. *Mosquito News,* 14:58–61.

DOWNES, J. A. 1955. Observations on the swarming flight and mating of *Culicoides* (Diptera: Ceratopogonidae). Trans. Roy. Ent. Soc. London, 106(Pt. 5):213–236, Plates I and II.

DOWNES, J. A. In preparation. The range of food habits of biting flies.

FREEMAN, T. N. 1952. Interim report of the distribution of the mosquitoes obtained in the Northern Insect Survey. Canada Dept. Natl. Def., Def. Res. Bd. Environmental Protection Tech. Rept. No. 1.

FREEMAN, T. N. In press. Present trends and future needs of entomological research in northern Canada. Part I. The Northern Insect Survey. Arctic (J. of the Arctic Inst. of N.A.).

HALL, R. R., DOWNE, A. E. R., MACLELLAN, C. R., and WEST, A. S. 1953. Evaluation of insect predator-prey relationships by precipitin test studies. *Mosquito News,* 13:199–204.

HAUFE, W. O. 1952. Observations on the biology of mosquitoes (Diptera:Culicidae) at Goose Bay, Labrador. Canadian Ent., 84:254–262.

HAUFE, W. O. 1953. Predicting mosquito emergence. Proc. 40th Ann. Meet. N. J. Mosq. Exterm. Assoc., pp. 52–57.

HAUFE, W. O. 1954. The effects of atmospheric pressure on the flight responses of *Aedes aegypti* (L.). Bull. Ent. Res., 45:507–526.

HAUFE, W. O. In preparation. The physical environment and behavior of immature stages of *Aedes communis* (Deg.) (Diptera:Culicidae) in subarctic Canada.

HAUFE, W. O., and BURGESS, L. In press. Development of *Aedes* mosquitoes at Fort Churchill, Manitoba, and the prediction of dates of emergence. Ecology.

HOCKING, B. 1953. The intrinsic range and speed of flight of insects. Trans. Roy. Ent. Soc. London, 104:223–345.

HOCKING, B. 1954. Flight muscle autolysis in *Aedes communis* (Degeer). *Mosquito News,* 14:121–123.

HURTIG, H. 1953. Development of the use of aircraft for the application of insecticides and fungicides. Agr. Inst. Rev., 8:73–74.

James, H. G. [1953] Notes on a preliminary survey of natural control of biting flies at Churchill, Manitoba. 32nd and 33rd Repts. Quebec Soc. Prot. Plants, 1950 and 1951, pp. 119–121.

James, H. G. In preparation. Field study of *Mochlonyx culiciformis* (Deg.) (Diptera:Culicidae)), a predator of mosquito larvae.

Judd, W. W. 1954. Results of a survey of mosquitoes conducted at London, Ontario, in 1952 with observations on the biology of the species collected. Canadian Ent., 86:101–108.

Kasman, S., Roadhouse, L. A. O., and Wright, G. F. 1953. Studies in testing insect repellents. *Mosquito News,* 13:116–123.

Kingscote, A. A. 1952. Studies on the internal administration of known and potential insect repellents. Canada Dept. Nat. Def., Def. Res. Bd. Environmental Protection Tech. Rept. No. 2.

Kingscote, A. A. 1954. Studies on the attractancy of laboratory rats to *Aedes aegypti* (L.). Canada Dept. Nat. Def., Def. Res. Bd. Environmental Protection Tech. Rept. No. 5.

Peterson, D. G. 1955. Biology and control of biting flies in pulpwood cutting areas. Pulp and Paper Magazine of Canada, 56:180, 183–4, 186.

Rempel, J. G. 1950. A guide to the mosquito larvae of Western Canada. Canadian J. Res., D, 28:207–248.

Rempel, J. G. 1953. The mosquitoes of Saskatchewan. Canadian J. Zool., 31:433–509.

Roadhouse, L. A. O. 1953. Laboratory studies on insect repellency. Canadian J. Zool., 31:535–546.

Shemanchuk, J. A., Spinks, J. W. T., and Fredeen, F. J. H. 1953. A method of tagging prairie mosquitoes (Diptera:Culicidae) with radio-phosphorus. Canadian Ent., 85:269–272.

Shemanchuk, J. A., Fredeen, F. J. H., and Kristjanson, A. M. 1955. Studies of the flight range and dispersal habits of *Aedes flavescens* (Müller) (Diptera:Culicidae) tagged with radio-phosphorus. Canadian Ent., 87:376–379.

Smart, M. R., and Brown, A. W. A. In press. Studies on the responses of the female *Aedes* mosquito. Part VII. The effect of skin temperature, hue, and moisture on attractiveness of the human hand. Bull. Ent. Res.

Stansfield, E. J. 1954. Some factors in the control of mosquitoes of Greater Winnipeg. Proc. Ent. Soc. Manitoba, 9:31–36. (processed).

Thompson, R. P., and Brown, A. W. A. 1955. The attractiveness of human sweat to mosquitoes and the role of carbon dioxide. *Mosquito News,* 15:80–84.

Twinn, C. R. 1949. Mosquitoes and mosquito control in Canada. *Mosquito News,* 9: 35–41.

Twinn, C. R. 1950. Studies on the biology and control of biting flies in northern Canada. Arctic (J. of the Arctic Inst. of N. A.), 3:14–26.

Twinn, C. R. 1952. A review of studies of blood-sucking flies in northern Canada. Canadian Ent., 84:22–28.

Twinn, C. R. 1953. Mosquitoes and their control in Prince Edward Island. *Mosquito News,* 13:185–190.

Twinn, C. R. In press. Present trends and future needs of entomological research in northern Canada. Part II. Biology and control of biting flies. Arctic (J. of the Arctic Inst. of N. A.).

Twinn, C. R., and Peterson, D. G. 1955. Control of mosquitoes in Canada. Canada Dept. Agr. Pub. 936 (14 pp.).

Vockeroth, J. R. 1950. Specific characters in tarsal claws of some species of *Aedes* (Diptera:Culicidae). Canadian Ent., 82:160–162.

Vockeroth, J. R. 1954a. Notes on northern species of *Aedes,* with descriptions of two new species (Diptera:Culicidae). Canadian Ent., 86: 109–116.

Vockeroth, J. R. 1954b. Notes on the identities and distributions of *Aedes* species of northern Canada, with a key to the females (Diptera:Culicidae). Canadian Ent., 86:241–255.

West, A. S., and Eligh, G. S. 1952. The rate of digestion of blood in mosquitoes. Precipitin test studies. Canadian J. Zool., 30:267–272.

See pages 237–240 for information on the AMCA meeting in Beaumont, Texas, in February.

TESTS WITH GRANULATED AND SYSTEMIC INSECTICIDES AGAINST *MANSONIA* LARVAE[1]

H. C. CHAPMAN
Entomology Research Branch, Agr. Res. Serv., U.S.D.A.

The immature stages of *Mansonia* attach to and obtain air from the roots of plants and thus differ from mosquitoes that obtain air by rising to the water surface. Since the plant roots are usually in a stratum of silt and debris, chemical control is difficult. Water management affords the best means of control, but often is impossible.

Little has been published on chemical control of *Mansonia* larvae. In New Jersey results of tests by Hagmann (1953) against *perturbans* (Wlkr.) on cattail indicate that satisfactory control was obtained from dieldrin pelleted dusts applied at 0.17 pound per acre. Aldrin and BHC at the same dosage and DDT at 1 pound per acre failed to give satisfactory reductions. These treatments were made in November and checked in January or February.

Field experiments near Boca Raton, Fla., in 1945 had shown that a DDT-xylene emulsion applied at 0.1 p.p.m., and stirred to give thorough dispersion, and a 1-percent DDT suspension at 2 p.p.m. gave excellent control in 24 hours. Poor initial reductions were obtained by surface applications of DDT-xylene emulsion at 1 pound per acre. These tests were conducted against populations that were predominantly *indubitans* D. and S., and the host plant was waterlettuce (*Pistia stratiotes*).

TESTS WITH GRANULATED INSECTICIDES. —In 1954 tests were conducted in the laboratory with 16/30-mesh granular bentonite containing 1 percent of various insecticides. The larvae were collected on waterlettuce at Boca Raton and Okeechobee, Fla., and were predominantly *indubitans,* but a few *titillans* (Wlkr.) were present. After the larvae had been forced to detach by shaking the roots in water, the plant was placed in a battery jar containing 2 liters of water, and 25 fourth-instar larvae were introduced. After the larvae had reattached, the granules were added to the water and mortality counts were taken after 48 hours. The results with 15 insecticides are given in Table 1.

Complete mortality was obtained with parathion at 0.025 p.p.m. and with EPN at 0.1 p.p.m. At 0.25 p.p.m. endrin and DDVP also gave complete mortality; lindane and dieldrin, mortalities above 90 percent, and the remaining insecticides were less effective.

In January and April 1955 field tests with 16/30-mesh bentonite granules were conducted on 10- by 20-foot plots at Boca Raton. The predominant species of *Mansonia* was *indubitans,* but some *titillans* and a few *perturbans* were present. The plots were in a closed ditch with a profuse growth of waterlettuce, infested during the January tests with up to 329 larvae, and during the April tests with up to 57 larvae per plant. The granules contained 1 percent of an insecticide and were broadcast by hand.

The sampling procedure consisted of quickly transferring a waterlettuce plant from the plot to a white enamel pan about half full of water, dislodging the larvae from the roots by severe agitation, and then removing the water by means of a fine-mesh strainer. The debris and larvae were spread out in a small amount of clear water in a small white enamel pan, and the larvae were removed and counted. All instars were present, but the third and fourth predominated. The percent control was calculated from the difference between the total number collected from five plants before and at various intervals after

[1] This work was conducted at the Orlando, Fla., laboratory of the Entomology Research Branch under funds allotted to the Branch by the Department of the Army.

Table 1.—Percent mortality of *Mansonia* larvae after 48-hour exposure in water treated with various granulated insecticides, 1954. (2 to 5 replications.)

Insecticide	0.25 p.p.m.	0.1 p.p.m.	0.05 p.p.m.	0.025 p.p.m.	0.01 p.p.m.
Parathion	100	100	100	100	8
EPN	100	100	82	70	10
Endrin	100	88	56	22	..
DDVP	100	79	30	12	0
Lindane	97	92	79	42	..
Dieldrin	95	52	40	16	..
BHC (12% gamma)	88	50	24	4	..
Bayer L 13/59	88	..	..	..	..
Malathion	84	..	..	..	..
Shell OS 2046	80	..	..	..	..
Heptachlor	54	..	..	..	..
Chlordane	39	..	..	..	..
DDT	21	..	..	..	..
Aldrin	19	..	..	..	..
Toxaphene	7	..	..	..	..

treatment. The results are presented in Table 2.

In the January tests EPN granules at 0.25 and 0.1 pound per acre caused excellent reductions after 24 hours and almost eliminated breeding for at least 3 weeks. The 0.05-pound dosage gave poor initial kill but was highly effective after 1 week and moderately effective after 3 weeks. Dieldrin granules at 0.1 pound per acre also gave low initial kill but were over 90 percent effective after 1 and 3 weeks. Breeding was still at an extremely low ebb after 10 weeks in these plots, but also in adjacent untreated areas. The larval populations remained unchanged at the opposite end of the ditch.

In the April treatments none of the materials gave good control in 24 hours. The best reductions after 1 and 3 weeks were obtained with endrin at 0.1 pound per acre. Lindane, DDVP, and parathion at this dosage did not give satisfactory control.

Tests with Systemic Insecticides.—In conjunction with the January tests of granulated insecticides, field tests were conducted with schradan and Systox to determine their systemic and direct action. The materials were applied in 1-percent

Table 2.—Field tests with granulated larvicides against *Mansonia* larvae, 1955

Insecticide and dosage (pound/acre)	Pretreatment count on 5 plants	Percent control after—		
		24 hours	1 week	3 weeks
	January treatment			
EPN 0.25	589	99	99	99
.1	393	97	96	99
.05	407	32	98	84
Dieldrin 0.1	443	38	92	95
	April treatment			
Parathion 0.25	131	35	53	76
.1	103	0	23	22
.05	48	6	2	21
Lindane 0.1	65	54	39	71
Endrin 0.1	105	14	88	90
DDVP 0.1	63	25	64	49

TABLE 3.—Field tests with emulsions of two systemic insecticides against *Mansonia* larvae, 1955

Insecticide and dosage (pound/acre)	Pretreatment count on 5 plants	Percent control after—		
		24 hours	1 week	3 weeks
Schradan 0.25	426	0	0	21
.1	216	51	0	0
.05	408	0	1	..
Systox 0.25	210	1	0	0
.1	163	0	0	0
.05	157	0	0	..

emulsions with a hand atomizer at three dosages. The results are given in Table 3.

Neither schradan nor Systox was effective initially, and no systemic action was noted at 1 or 3 weeks.

SUMMARY.—Of 15 granulated insecticides tested in the laboratory against *Mansonia* mosquito larvae, only 6 gave more than 90 percent mortality at 0.25 p.p.m. These were parathion, EPN, endrin, lindane, DDVP, and dieldrin, in order of decreasing toxicity. When these materials were tested in the field, EPN at 0.25 and 0.1 pound per acre gave excellent control after 24 hours to 3 weeks, and dieldrin and endrin at 0.1 pound gave poor control initially but good control after 1 and 3 weeks. Lindane, DDVP, and parathion were not satisfactory at this dosage.

No direct or systemic action after 3 weeks was noted from Systox or schradan when applied at 0.25 pound per acre.

References Cited

HAGMANN, L. E. 1953. Biology of *Mansonia perturbans* (Walker). N. J. Mosquito Extermin. Assoc. Proc., 40:141–7.

IMPORTANT NEW INFORMATION of interest to all mosquito control workers will be presented at the AMCA meetings in Beaumont, Texas in February. See pages 239 and 240 for partial list of papers to be presented.

The Ninth Annual Conference of the Utah Mosquito Abatement Association will be held on March 16 and 17, 1956, at Midvale, Utah. The South Salt Lake County Mosquito Abatement District will serve as hosts. This is your invitation to attend.

MAXILLARY INDEX AND BIOLOGICAL RACES IN *ANOPHELES GAMBIAE* GILES

JEAN W. FOX AND RICHARD M. FOX

The Liberian Institute of the American Foundation for Tropical Medicine
Harbel, Liberia, West Africa *

Recently there has been an effort by entomologists in Africa to use maxillary dentition to distinguish races in *Anopheles gambiae*. Holstein's studies (1949, 1954) in the Sehelian and Sudanese savanna zones of French West Africa led him to conclude that *A. gambiae* should be divided into two races: a paucidentate anthropophilic race with a mean maxillary index of 13.5, and a multidentate zoophilic race with a mean maxillary index of 15. Campbell (1951) found that his catches of *A. gambiae* in Gambia represented two races: a paucidentate race with a mean maxillary index of 13.1 breeding in casual water with low chlorophyl content, and a multidentate race with a mean maxillary index of 15.3 breeding in permanent water containing photosynthetic microflora. Maillot (1953) reported on 600 *A. gambiae* collected near Brazzaville, French Equatorial Africa, comparing the maxillary index and the sporozoite rate, concluded that there are two races: a paucidentate anthropophilous race and a multidentate, less anthropophilous, race.

Gillies (1954), working with *A. gambiae* in Tanganyika, takes vigorous exception to Holstein's and Campbell's conclusions on two races and thinks "it would be unfortunate if the impression were to gain credence among malariologists, who have not had first hand experience with *A. gambiae*, that these conclusions are proved and beyond dispute." He found that crowded larval conditions lead to lower maxillary index; he found no difference in the maxillary indices of *gambiae* feeding on cattle and those feeding on man.

We have dissected 621 *A. gambiae* collected in the vicinity of the Liberian Institute in order to study the value of the maxillary index as a criterion for two races, as well as to ascertain the status in this region of possible infraspecific groupings along the lines advocated by Holstein and by Campbell.

Materials and Methods. Of the 621 *A. gambiae* reported here, 162 were from the eighth and ninth generations of the Zopablo strain of our laboratory colony, while 457 were collected in the field by use of man-baited traps, by night collecting and by hut surveys. Thirty-one of the field collected mosquitoes came from labor work camps on the Firestone rubber plantation; 271 came from five villages in Charlesville Township, Marshall Territory, all within a mile of the Institute. Finally, 149 mosquitoes were collected, using the man-baited trap and night collecting, beside a fairly large permanent swamp, with the nearest dwelling some distance away.

The colony mosquitoes dissected had fed on malarious patients during the course of other experiments; previously an unknown but substantial number of these mosquitoes had fed on rabbit blood during their wait for experimental use. As larvae they were reared in distilled water and fed on a mixture of cracker dust and dry yeast.

Ecological conditions in this region are quite different from those pertaining where Holstein and Campbell worked. Briscoe (1952) recorded an average rainfall of 146.28 inches each year for a three-year period. There is no month without some precipitation, even during the dry season. About a mile to the south of the Institute the coastal savanna begins. From here north the country was originally rain forest but now is under sporadic cultivation and is mostly covered with low second growth bush, except the Firestone rubber plantation which is thickly planted with Brazilian *Hevea*. The region

* Cost of publication in this issue paid by the Institute.

includes several rivers, many creeks and smaller streams and a great deal of swampy land. Casual water is available virtually throughout the year. The nearest brackish and salt water is at least two and a half miles to the south and represents the nearest approach of *A. gambiae melas,* which previous study through egg identification demonstrated was absent from all the collecting sites used. A few goats, dogs and pigs are found in the villages; there is a sparse population of water deer in the bush and some small mammals. There are no cattle or antelope.

To count the maxillary teeth we found a method much simpler than that described by Holstein (1954). The heads were placed in a drop of lactophenol under a binocular dissecting microscope and the mouth parts pressed with the side of a bent needle placed at the proximal end of the proboscis. The pressure causes the elements in the proboscis to separate. The procedure is effective equally with fresh material or with specimens preserved in alcohol, although in the latter case it was found that the mouth parts sometimes disassociated spontaneously while in storage. The mouth parts then were severed from the head, which was discarded, and a cover slip placed over them. The maxillae were located and the teeth counted at about 660 diameters with a compound microscope using 15 x oculars and a 44 x objective; it was found unnecessary to employ immersion objectives.

Our data are grouped into three aggregates: those collected in and around dwellings, both at the Charlesville sites (279 mosquitoes) and on the rubber plantation (31 mosquitoes); those collected over the permanent swamp (149 mosquitoes); those from the laboratory colony (162 mosquitoes).

RESULTS. Table 1. summarizes the data for the collection as a whole and for each of the three aggregates defined above. The mean maxillary index for each aggregate was calculated by the formula $M = \frac{\Sigma (fx)}{N}$. Since the means vary only by 0.2 (Table 1), there is no statistical indication that we are dealing with unlike populations.

TABLE 1.—Frequency distribution of maxillary indices

Maxillary index [1] (A)	Total Collection (B)	Coll. in and near Dwellings (C)	Human bait near swamp (D)	From lab. Colony (E)
11	1	1	0	0
11.5	5	3	2	0
12	6	4	2	0
12.5	19	11	6	2
13	49	25	15	9
13.5	58	27	12	19
14	101	59	18	24
14.5	96	49	25	22
15	101	46	24	31
15.5	72	30	23	19
16	56	25	13	18
16.5	37	19	4	14
17	13	6	3	4
17.5	5	3	2	0
18	1	1	0	0
18.5	0	0	0	0
19	0	0	0	0
19.5	1	1	0	0
Totals	621	310	149	162
Means	14.6	14.6	14.6	14.8

[1] Column A, maxillary index, the sum of the teeth on both maxillae divided by two.

Histograms, Figures 1 to 4, illustrate the frequency distributions of the respective aggregates as listed in Table 1. From inspection all these except Figure 4, the colony mosquitoes, indicate a distribution fairly close to that of the normal curve and fall into the pattern specified by Quatelet's law. By way of verification, the standard deviation (σ) for each group was computed and the dispersion calculated, with the results shown in Table 2. According to Simpson and Roe (1939), dispersion limits for the normal curve are 68 percent of sample within one σ of the mean, 95.5 percent within 2σ and 99.76 percent within 3σ. The total range should be 6σ, $(M+3\sigma)$ to $(M-3\sigma)$. As will be noted from column B of Table 2, the total collection (Fig. 1) conforms unusually well to the statistical definition for the normal curve. For both the human habitation mosquitoes (Fig. 2) and the swamp mosquitoes (Fig. 3) it will be noted that the 93 percent of specimens

Table 2.—Percentage dispersion of data

	N	σ	(M$\pm\sigma$)	(M$\pm 2\sigma$)	(M$\pm 3\sigma$)
Total collection	621	1.1	68	94.4	99.8
From habitations	310	1.2	68	93	99
From swamp	149	1.2	68	93	99
From colony	162	1.2	82	100	....

lying within the 2σ range of M is slightly lower than expected for a perfectly normal curve, but this small departure does not seem significant—particularly in view of Simpson and Roe's warning (1939, p. 129) to zoologists that no real distribution ever actually fits exactly any purely mathematical concept.

It is interesting to note that the dispersion in the colony mosquitoes (Fig. 4) shows definite grouping within a range of 4σ. This is to be expected since these specimens were reared from inbred stock under artificial conditions.

All our aggregates are multidentate, with the means of the maxillary indices close to the defined mean of 15 to 15.3 but distant from the paucidentate mean of 13.1 to 13.5.

Discussion. According to the view held by Campbell (1951), these multidentate *gambiae* ought to have developed as larvae in permanent water. One of our aggregates was indeed collected over a permanent swamp and conforms to Campbell's thesis. The breeding water of the field collected mosquitoes is not known, of course, but since both casual and permanent waters are available in the vicinity, this group probably is mixed in that respect, although the histogram of maxillary indices (Fig. 2) does not differ appreciably from the maxillary indices of the swamp group (Fig. 3). The colony mosquitoes developed in distilled water under conditions closer to those of casual water than of permanent water, but identical with neither. Nevertheless the distribution of their maxillary indices (Fig. 4) conforms closely to the other aggregates.

According to Holstein's theory (1949, 1954), our multidentate *gambiae* ought to be zoophilic. But both the field collected aggregates—those from the permanent swamp and those from dwellings—were collected at human bait, hence may be presumed to be anthropophilic, or at least satisfied to feed on human blood. The mosquitoes from the colony all were known to have fed on humans, but many of them previously had taken a meal of rabbit blood. In view of the lack of large herds either of game or of domestic animals in this part of Africa it appears quite unlikely that any race of *gambiae* having a hereditary zoophily could maintain itself. One would expect, then, that the maxillary indices of the local *gambiae* would be paucidentate. Since the opposite is true, it may not be amiss to reexamine the two-race theory.

A pivotal question arises at once: just what did Campbell and Holstein each mean by the word *race?* Was the word used in its specifically correct sense to designate an unnamable infraspecific population of less value than the subspecies, thus more or less synonymously with the word *strain* as frequently used in microbiology and in animal colony work? Or was the word used to designate the principal infraspecific taxon, hence in the sense synonymous with *subspecies?* Although this second usage is no longer considered to be correct, it persists in some quarters and is usual among culicidologists. Campbell (1951) mentions several times his two races as though he thought they were categorically equal to *A. gambiae melas,* a subspecies, although he refers to *melas* as a *variety.* This is another word devoid of systematic precision. In his discussion headed "Systematic position of the populations," Holstein (1954, pp. 142–143) strongly implies, without actually making his position clear, that his races are namable subspecies. Edwards (1954) has called attention to the misuse

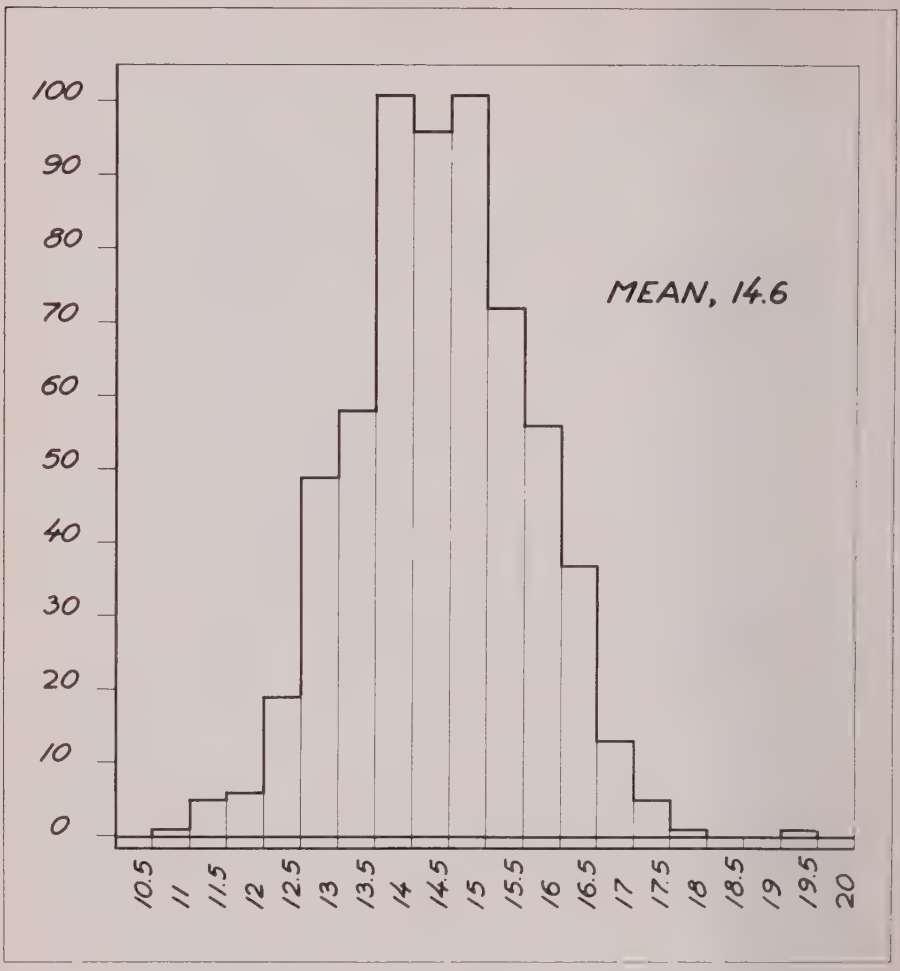


FIG. 1. Frequency distribution of maxillary indices of total collection.

of terms such as *race* and *variety* and to the abuse of statistical methods in defining infraspecific categories. Fox (1955) has emphasized the importance of clarifying the biological concepts underlying infraspecific systematics. There is almost universal agreement that the naming of physiologic populations and of populations recognizable only statistically leads to useless confusion.

That Holstein refrains from naming his races is beside the point; we are interested in his biological thinking. Certainly both Campbell and Holstein felt that they were dealing with two major fractions of *gambiae,* distinguished by feeding tropisms, by preferences in larval water and by maxillary index.

The hitch in each case is that the two races were sympatric. In the light of modern research on speciation and evolution (the literature is enormous, but Dobzhansky (1951), Fisher (1930) and Mayr (1942) are standard references), it is evi-

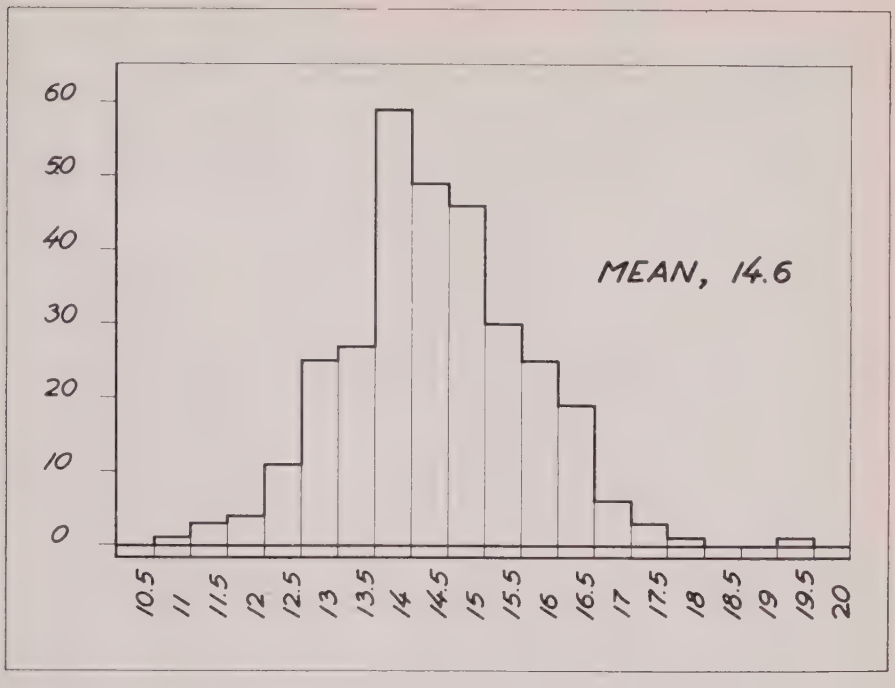


FIG. 2. Frequency distribution of maxillary indices of mosquitoes collected in and near human habitations.

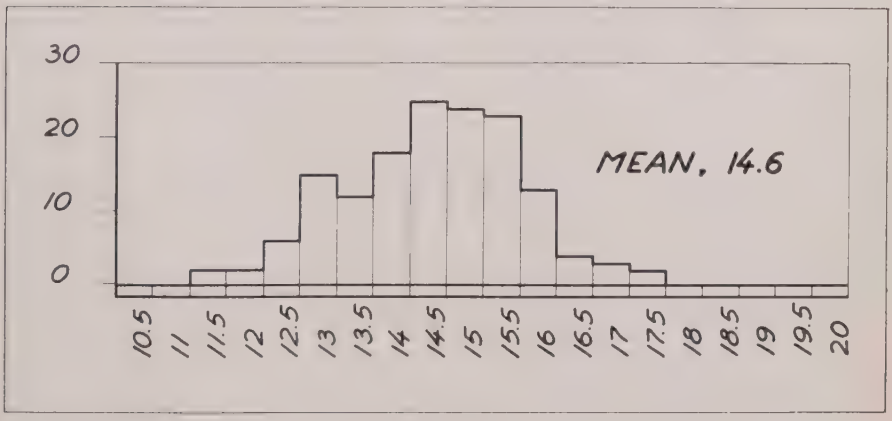


FIG. 3. Frequency distribution of maxillary indices of mosquitoes collected with human bait over a permanent swamp.

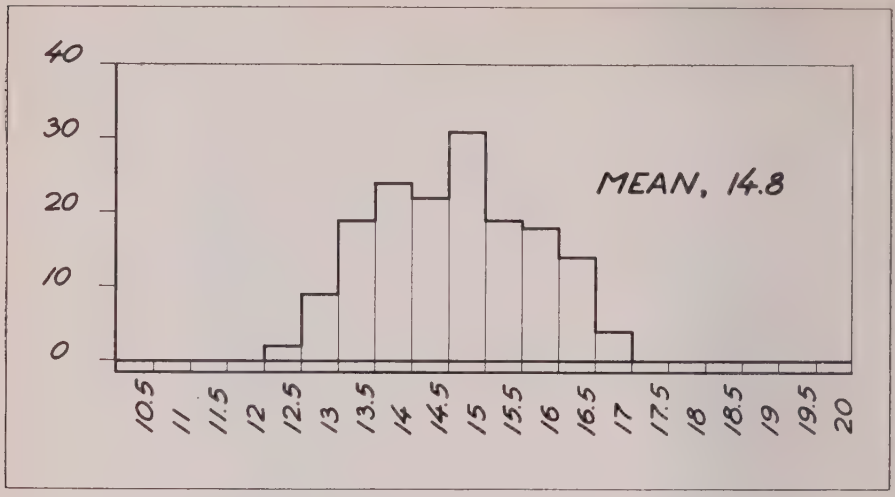


FIG. 4. Frequency distribution of maxillary indices of mosquitoes from laboratory colony.

dent that two genetically distinct populations cannot preserve their separate identities without sexual isolation. Between the different populations of a species, sexual isolation when it exists, is almost invariably the result of geographic isolation and results in the formation of subspecies. But two such populations made sympatric will inevitably undergo gene exchange and their distinctiveness will soon be obliterated. Since neither Campbell nor Holstein demonstrated sexual isolation between their races, it is evident that the explanation for the "significant differences" found in their data must be sought elsewhere than in ascribing them to firm biological populations.

When dealing with living things, statistical results must be interpreted with caution. In analyzing his samples, Campbell calls attention to the fact that his total frequency distribution shows a platykurtic curve, leading him to conclude that two populations were involved. That this conclusion is not necessarily sound is underlined by Simpson and Roe (1939, p. 202) who point out that some homogeneous distributions are platykurtic and merely reflect a high variability within a single natural population. They further call attention to the law of ecological incompatibility—which has nothing to do with mathematics but which is sound zoology: "really separable taxonomic groups of animals such that all their variates have extensive overlapping distributions are seldom found in nature" (1939, p. 200). According to Campbell's data, 75 percent of all his specimens, those with 12.5 to 15.5 teeth, would fall into the netherland of overlapping range. Holstein, too, ignores the law of ecologic incompatibility in establishing two races. The overlap of ranges for his paucidentate and multidentate races is between the maxillary indices of 12 and 15.5. According to his table xxiv (1954, p. 129), 92.1 percent of those mosquitoes listed in the paucidentate column and 70.2 percent of those listed as multidentate fall into this dubious category. Only 7.9 percent of his paucidentates are unquestionably so, and only 29.8 percent of his multidentates cannot be suspected of being incorrectly listed. These very extensive overlaps suggest that the differences between the two populations in each case are both minor and unimportant.

Holstein reports that his populations 1 to 9, chiefly bush captures, have higher maxillary indices, a lower proportion of positive precipitation reactions with human

antiserum and a high proportion of positive reactions with the antisera of other animals; his populations 10 to 19 show the reverse trend and were mainly collected in and around human habitations (1954, pp. 131, 133). Since his populations 1 to 9 have mean maxillary indices ranging from 14.7 to 15.5, whereas his populations 10 to 19 have mean maxillary indices ranging from 12.0 to 13.8, he not unnaturally concludes that there is a correlation—which there is, statistically, perhaps. But the highest paucidentate mean differs from the lowest multidentate mean only by 0.9 teeth, and the futility of defining the vast majority of individuals as either type has already been noted.

Gillies (1954) indicates that crowded conditions during larval life rather than the nature of the breeding water, influences maxillary index. He records lowering the maxillary index of a strain from 15.7 to 13.9 by rearing the larvae under crowded conditions. Further, he found no difference in the maxillary indices of individuals feeding on cattle and those feeding on man.

An alternative explanation for Holstein's 19 populations may be that populations 1 to 9, collected for the most part in sparsely populated areas, passed their larval instars in uncrowded waters, but that populations 10 to 19, collected in and near dwellings, passed their larval instars in waters crowded by the offspring of the better and more regularly fed females frequenting villages and towns.

In *Anopheles gambiae* we have, as might be expected of a common and widely distributed animal, a highly adaptable species with a well developed ability to survive under diverse conditions. The female feeds on mammalian blood; no doubt the choice between animal and man is determined by chance availability. Certainly our own experience with *gambiae* in our laboratory colony, where the insects feed both on human blood and on rabbit blood, whichever is offered, tends to weaken concepts of obligatory feeding tropisms. It is our impression that when *gambiae* females need a blood meal, the first available source—man or animal—will serve.

Nor can we find that a case has been made for an inherited preference for ovipositing in casual versus permanent water in *gambiae,* a concept necessarily embodied in Campbell's theory. When the eggs mature in the female, they must be laid; there is nothing to suggest that the first available water will not be utilized for the purpose. Certainly our colony mosquitoes cooperatively and prolifically deposit their eggs on moist filter paper, suggesting that if there is a tropism in this respect, it is readily overcome by necessity.

To dismiss as abnormal and not significant the behavior of mosquitoes in a colony is a sophistry all too tempting to the field investigator. If a behavior pattern or a tropism is indeed inherent in the animal, it should be manifested in the colony animal as well as under wild conditions.

Campbell defines permanent water as having an established photosynthetic microflora; our swamp collections were made over such a place. These show (Fig. 3) a mean maxillary index of 14.6 with a range of 11.5 to 17.5, not seriously deviating from Campbell's findings. On the other hand, our colony specimens, reared in sterile water, showed (Fig. 4) a slightly higher maxillary index of 14.8 and the narrower range of 12.5 to 17.0. In view of Gillies' findings (1954), this almost certainly indicates that both groups of mosquitoes developed as larvae without being crowded. This is known to be true of the colony, where we are careful not to crowd the larvae and constantly make every effort to afford conditions optimum for development. If indeed there were a true relationship between maxillary index and the photosynthetic microflora as such in the larval environment as Campbell thought, one would expect the colony mosquitoes to exhibit paucidentatism in these eighth and ninth generations developed in water from which microflora has been rigidly excluded. On the contrary, the maxillary index of this group turns out to be, if anything, slightly higher than that of the group collected

from the swamp. Perhaps the presence of the photosynthetic microflora may be taken as an ecological indicator of natural water likely to favor uncrowded conditions for mosquito larvae, rather than as a factor with direct influence on the number of maxillary teeth.

SUMMARY AND CONCLUSIONS. The maxillary indices of 621 *Anopheles gambiae* Giles collected in Marshall Territory, Liberia, were studied. The collection was divided into three aggregates according to ecological backgrounds: (1) those collected in and near human habitations, (2) those collected over a permanent swamp, (3) those from the laboratory colony.

The mean maxillary index of the total collection was 14.6 with a range from 11 to 19.5 Analysis of the data showed that dispersion of the frequencies lay almost exactly within the limits of a normal curve, hence indicated a pure population. The mean maxillary index for each aggregate was determined. The swamp mosquitoes and those collected at dwellings both showed a mean maxillary index identical with the total collection. The colony aggregate showed a mean maxillary index of 14.8, or a variance of 0.2 teeth. These findings are contrary to expectancy under the two race theories advanced by Campbell and by Holstein, leading us to review the works concerned.

A basic fallacy in these theories lies in the fact that the paucidentate and the multidentate races of Campbell and of Holstein were, in each case, sympatric, precluding the possibility of their maintaining genetic distinctiveness unless sexual isolation exists. Since sexual isolation has not been demonstrated, it is theoretically unlikely that these are races. Both authors appear to have dealt with homogeneous but variable populations. A platykurtic distributional curve does not necessarily indicate the existence of two biologic populations. Use of maxillary index to define the paucidentate and multidentate populations as races (subspecies?) violates the law of ecological incompatibility in that the overlapping range of maxillary indices is much too large. As is to be expected of a widely distributed, adaptable insect, *gambiae* females evidently incline to deposit eggs in the first available water found after the eggs mature and will take blood meals from the most convenient donor—man or animal—with preference being shown for man when a choice is available.

References

BRISCOE, M. S. 1952. The relation of insects and insect-borne diseases to the vegetation and environment in Liberia. Ecology, 33:187–214.

CAMPBELL, R. W. 1951. Maxillary indices of *Anopheles gambiae*. Bull. Ent. Res., 42:647–658.

DOBZHANSKY, T. 1951. Genetics and the Origin of Species. 3rd edition. New York, Columbia University Press.

EDWARDS, J. G. 1954. A new approach to infraspecific categories. Syst. Zool., 3:1–20.

FISHER, R. A. 1930. The genetical theory of natural selection. Oxford, Oxford University Press.

FOX, R. M. 1955. On subspecies. Syst. Zool., 4:93–95.

GILLIES, M. T. 1954. Biological races of *Anopheles gambiae*. Trans. Roy. Soc. Trop. Med. Hyg., 48:443–445.

HOLSTEIN, M. H. 1949. Le probleme d'*Anopheles gambiae*. Bull. Med. Afr. Occid. Franç., no. spec.:155–160.

HOLSTEIN, M. H. 1954. Biology of *Anopheles gambiae*. Geneva: World Health Organization, Monograph series, No. 9. [English translation with additions and amendments by the author; French version published 1952.]

MAILLOT, L. 1953. Etude de l'infection palustre et de l'indice maxillaire chez *A. gambiae* Giles a Brazzaville de decembre 1950 a fevrier 1951. Bull. Soc. Path. Exot., 46:839–847.

MAYR, E. 1942. Systematics and the Origin of Species. New York, Columbia University Press.

SIMPSON, G. G., and ROE, A. 1939. Quantitative Zoology. New York, McGraw-Hill Book Co., Inc.

METHODS FOR DISSECTING SALIVARY GLANDS IN MOSQUITO LARVAE AND PUPAE[1]

DINNIEMAUD V. JENSEN

Although detailed instructions exist for the removal of the salivary glands from adult mosquitoes (e.g., Russell, West, and Manwell, 1946), there seems to be no description of how these glands may be removed from larvae and pupae.

This paper briefly describes and illustrates several methods by which salivary glands may be easily extracted from larvae of all stages and pupae of *Anopheles albimanus* Wiedemann.[2]

Equipment. The following items or their equivalents are needed for an adequate study: (1) a binocular stereoscopic microscope permitting magnifications of 30–40 diameters, (2) a compound microscope (100×), (3) orangewood sticks, (4) No. 1 insect pins, (5) microscope slide, (6) filter paper (Whatman No. 1), (7) medicine droppers, and (8) 0.85 percent sodium chloride.

Dissecting needles can be made by embedding No. 1 insect pins firmly into orangewood sticks. Both straight and bent needles are necessary. The bending may be done with small forceps or pliers, a 90° bend being most desirable. The tips of the needles should be sharpened on an oil stone or an emery wheel.

Preparation for Dissection. A larva is placed dorsal side up in a drop of water on a glass slide. Pupae are placed in a lateral position. The specimen is partially immobilized by quickly removing the water around it with filter paper cut into small triangular pieces. The slide is then orientated on the stage of a dissecting microscope so that the head of the larva or pupa is to the operator's right. The salivary glands usually can be seen in the intact larva, lying in the thorax (Plate I, Fig 1a).

Techniques for Removal of Larval Glands.

First Method:

(a) Hold body firmly in place by putting one bent needle between thorax and first abdominal segment (Fig. 1a).

(b) Sever head with other bent needle.

(c) Place this same needle across metathorax. Push gently downward and slowly and steadily forward (Fig. 1b) so as to express thoracic contents through anterior opening. Straight needles, used in the same manner, are needed in removing glands from young first instar larvae.

(d) Remove fat body and other undesirable material which may obscure glands, using pieces of filter paper.

(e) Add drop of saline with medicine dropper and examine.

Second Method:

(a) Hold body of larva in place as in 1a.

(b) Do not remove the head.

(c) Insert sharp bent needle just under mid-dorsal surface of thorax at posterior margin and make shallow slit up to the anterior end of thorax.

(d) Put elbow of needle between head and thorax (Fig. 2a).

(e) Exert opposite traction on needles as shown by arrows in Fig. 2b so that glands come out still attached to head.

(f) Examine in saline.

Third Method:

(a) Anchor body firmly as in 1a.

(b) Remove head.

(c) Using sharp bent needle, make mid-dorsal longitudinal slit from posterior to anterior end of thorax (Fig. 3a).

(d) Tease out glands in drop of saline with needles as shown in Fig. 3b.

[1] From the Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Microbiological Institute, Bethesda 14, Maryland.

[2] The mosquitoes used in this study were reared in the insectary of the Laboratory of Tropical Diseases using methods described by Trembley (1955).

(c) Remove fat body and other undesirable debris.

The first method is especially useful with first instar larvae. The second is used when it is desirable to remove both glands and their ducts. The third is the most efficient and can be used with all stages, except first instars.

TECHNIQUES FOR REMOVAL OF PUPAL GLANDS.

First Method (for pupae less than one day old):

(a) Hold pupa firmly on side with one needle at posterior edge of cephalothorax and remove head as shown in Fig. 4a.

(b) Push another bent needle very gently but firmly downward on middle of thorax and slowly move it forward thus pressing out thoracic contents (Fig. 4b).

(c) Absorb extraneous material with filter paper.

(d) Examine saline mount for degenerating pre-imaginal glands or for developing imaginal glands.

The newly-forming minute imaginal glands are best observed by using a compound microscope (100×). Those in the male appear as two tiny and highly refractile clavate structures; in the female they are minute and tri-lobed.

Second Method (for pupae one day old or over):

(a) Uncurl mouthparts and abdomen and straighten same into adult position (Fig. 5).

(b) Remove legs carefully.

(c) Hold thorax firmly with one needle.

(d) Place another needle at junction of head and mouthparts.

(e) Pull gently with needles in opposite directions (note arrows in Fig. 5) so as to separate head from thorax.

(f) Pull out imaginal glands attached to head.

(g) Examine in saline.

Literature Cited

RUSSELL, P. F., WEST, L. S., and MANWELL, R. D. 1946. Practical Malariology, W. B. Saunders, Philadephia, pp. 245–246.

TREMBLEY, H. L. 1955. Mosquito Culture Techniques and Experimental Procedures, Amer. Mosq. Cont. Assoc. Bull. No. 3, pp. 15–16.

FIG. 1. Dorsal view of larva with (a) position of dissecting needles at start of dissection and (b) after completion of dissection.

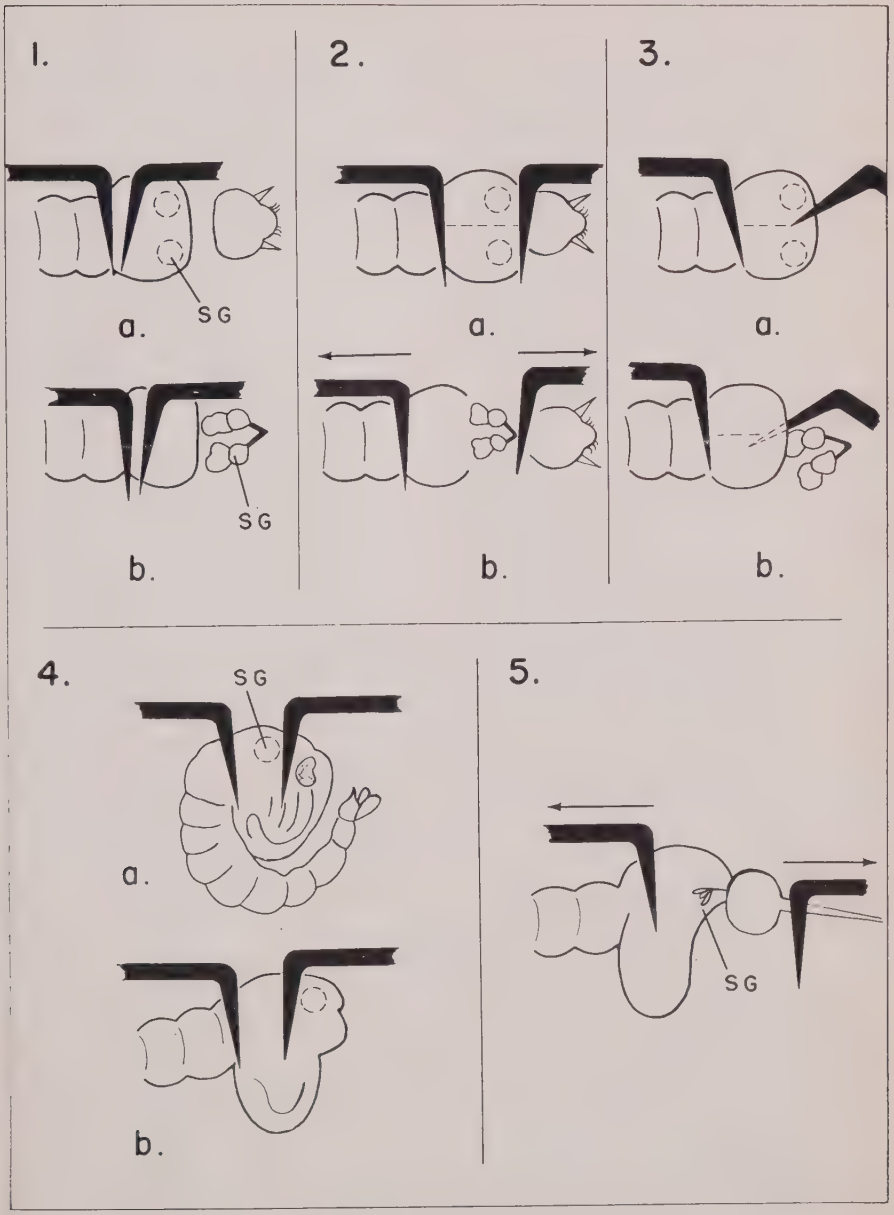
FIG. 2. Larva showing (a) position of needles at start of dissection and (b) direction of pull exerted by needles as salivary glands and ducts are pulled out attached to head capsule.

FIG. 3. View of larva showing position of needles (a) while making longitudinal slit in thorax and (b) while expressing salivary glands from thorax.

FIG. 4. Lateral aspect of pupa with position of needles (a) at start of dissection and (b) just prior to pressing the glands out anteriorly.

FIG. 5. Lateral view of pupa with mouthparts uncurled, showing position of needles and direction of pull as imaginal glands are pulled out attached to head capsule. S.G. denotes salivary glands.

Plate I
(Diagrammatic)



REPORT OF THE INITIAL OPERATION OF A MOSQUITO LIGHT TRAP IN NORTHERN THAILAND

DEED C. THURMAN, JR.,[1] AND ERNESTINE B. THURMAN[2]

The operation of a light trap (New Jersey type) in connection with the malaria control program in northern Thailand, expanded through American cooperation initiated in 1951, had a two-fold purpose: (1) To demonstrate the instrument in an area where it had not been used, particularly to show the malaria control officials and technical trainees the methods of operating the trap and handling the collections; and (2) to sample the mosquito population as to species, density, seasonal distribution, phototropism, and nocturnal flight activities.

This report, based on the first year of operation of a light trap in Chiengmai, northern Thailand, is presented with the hope that it will serve to assist additional light trap studies now in progress. Subsequent to the period of this report, New Jersey type light traps have been operated in Chiengmai and other areas, including three northern, twelve northeastern, three central and two southern locations. The collections to date have been largely obtained during variable periods of relatively short duration, though one of the traps in Bangkok has been operated since late March, 1952. All of these additional collections are now under study in Thailand, and further light trap investigations are being continued (Griffith, 1955).

A portable light trap, adapted to current from a 6-volt battery, was designed and constructed by the authors for use in northern areas where electricity was not available. This trap was operated on six occasions in the foothills of Doi (mountain) Sutep, Chiengmai Province, and once in the municipality of Chiengmai. The species attracted were the same as those taken in the New Jersey type trap in Chiengmai. The number of specimens and names of species have been included in the general tabulation, as the number of collections was too few to warrant separate evaluation.

After the mosquitoes were removed from each trap collection, the remaining insects were sorted to order and forwarded to specialists in the United States National Museum and military and academic agencies, or the collections of residue were forwarded in entirety to the interested agencies. This report deals only with the mosquitoes recovered.

During the 1951 spray-season of the expanded Thailand malaria control program, it was not possible to operate a light trap due to the insufficient supply of municipal electricity. The first trap was operated inside the Thurmans' residential compound in the city of Chiengmai. The beginning collections, one in March and six in April, 1952, were made utilizing the electricity as available, usually for not more than three hours a night. After April 16, a 24-hour supply of electricity was fairly constant, though the current fluctuated. Between this date and April 15, 1953, depending on the supply of electricity, the trap was operated during 282 nights. A total of 28,962 mosquitoes was identified, of which there were

[1] Sanitarian, Division of International Health, United States Public Health Service, assigned to the Thailand mission, Foreign Operations Administration, as Malaria Control Adviser, Northern Region, 1951–53.

[2] Sanitarian (R), Division of Research Grants, National Institutes of Health, United States Public Health Service, formerly with the Division of International Health and assigned to the Thailand mission, Foreign Operations Administration, as Malaria Control Training Adviser and Entomologist, 1952–54.

This investigation was supported in part by a research grant (E 809) from the National Microbiological Institute, National Institutes of Health, U. S. Public Health Service.

Facilities of the United States National Museum were utilized by the junior author to complete this report, one of a series of papers that was in preparation at the time of the sudden death of the senior author. Mr. Thurman died April 18, 1953, nine days prior to the completion of his assignment in Northern Thailand where he had spent more than two years.

17,377 females and 11,585 males (1.5 times as many females as males). There were 5,273 *Anopheles* collected.

Anopheles minimus Theobald, 1901, the only known vector of malaria in northern Thailand, was not collected in the trap, and in the same period this species was not collected in repeated larval collections and house inspections within the Chiengmai municipality. *A. minimus* was abundant in the Chiengmai area prior to the 1951 malaria control operations by DDT residual house-spraying. Larvae and adults were present concurrently in uncontrolled areas some 10 kilometers from the municipality.

Causey (1937) reports operating light traps in houses in Bangkok during 1933 from which he collected 3,817 *Anopheles* including one specimen of *A. minimus*. However, the degree of attractiveness of a New Jersey type light trap to *A. minimus* in Thailand remains to be ascertained. It would seem that if *A. minimus* is attracted to such a light trap, it could have been expected to appear in the Chiengmai trap in considerable numbers had the area not been subjected to DDT residual house-spraying during the previous year.

Mosquitoes were captured throughout the year with the exception of 15 nights during late December and mid-January when the pre-dawn temperatures dropped below 45° F. Northern Thailand is subjected to the monsoons with the rainy season beginning in late May or early June and continuing until mid-October, with September usually being the month for floods. November through January constitutes the dry-cool season, and February through April the dry-hot season. A few scattered showers (little monsoon) may occur in late March or early April.

Population trends of the culicines, as shown in Figure 1, seem to be correlated with the seasons. This is demonstrated by an increase from 14 culicines per trap-night in May to 283 in August. With the onset of the September floods followed by the dry-cool season, the culicine population diminished rapidly, dropping to 5 per trap-night in January. Species of *Culex* predominated throughout the year. Species of *Aedes* were most abundant during June and July.

The anopheline density peak of 61 per trap-night was reached in November. This peak was preceded by a peak of 50 per trap-night for August after a continuous increase from 2 per trap-night in May.

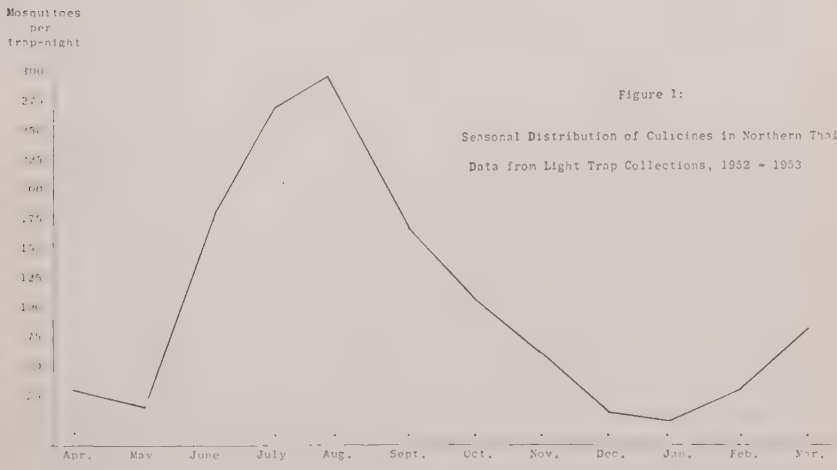


Figure 1:

Seasonal Distribution of Culicines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953

March, April, and May were the months in which malaria control teams sprayed the sleeping quarters of the houses with a 5 percent DDT suspension. During the September floods, anopheline catches were reduced to 16 per trap-night. The November peak was followed by a sharp decline to 3 per trap-night for December and to less than 1 for January, as is shown in Figure 2.

Before the mosquitoes were removed from a trap collection, the volume of the entire collection was measured in cubic centimeters. During the month of November, mosquitoes averaged 7.9 per cc. while during December the mosquitoes averaged 2.4 per cc.

Nocturnal flight activities of the mosquitoes were studied on four occasions by operating the trap for intervals of 3 hours between 6:00 p.m. and 6:00 a.m. Of the anophelines, 52 percent were captured between 6.00 and 9:00 p.m.; 29 percent from 9:00 p.m. to midnight; 11 percent between midnight and 3:00 a.m.; and 7 percent from 3:00 to 6:00 a.m. Culicine flight activity declined less abruptly during the four periods, from 31 percent to 17 percent as shown in Figure 3.

Of the 18 genera and estimated 200 species of mosquitoes occurring in Thailand, 11 genera (60%) and 66 species (33%) were represented in the total trap collection. (See ¶ 5 on p. 218). Of these, one genus and 11 species of six genera constitute new occurrence records for the country. (See ¶ 4 on p. 223). The *Culex* spp. constituted 78 percent of the total collection; *Anopheles* 18 percent; and the remaining nine genera, 4 percent.

Of the 43 species and subspecies of *Anopheles* reported for Thailand, of which 28 are known from northern Thailand, 13 were collected in the light trap. *Anopheles vagus* Dönitz, 1902, was the most abundant (37%), and was the only species collected during all the months of the year. *Anopheles philippinensis* Ludlow, 1902 (20%), *Anopheles aconitus* Dönitz, 1902 (13%), *Anopheles nigerrimus,* Giles, 1900 (13%), and *Anopheles sinensis* Wiedemann, 1828 (12%) were collected in abundance. Other species collected rarely, comprising 5 percent of the anophelines, are listed under the heading *Species of Mosquitoes Captured* in order of frequency of occurrence.

All 13 *Anopheles* trapped in northern Thailand have been reported as experimental or natural vectors of malaria for countries of the Indo-Australian Region (Bonne-Wepster and Swellengrebel, 1953). However, after repeated dissections, only *A. minimus* has been found naturally infected with sporozoites in Thailand (Bhayung, 1935; Sambasivan, Bhatia, Pranich, and Notananda, 1952). *A. barbirostris, A. nigerrimus,* and *A. sinensis* have been reported as vectors of filariasis in southern Thailand (Iyengar, 1953).

In the culicines, the genus *Culex* predominated (80%). *Culex fuscocephalus* Theobald, 1907; *Culex pipiens* Linneaus, 1758—*Culex quinquefasciatus* Say, 1823, complex; *Culex tritaeniorhynchus* Giles, 1901; *Culex vishnui* Theobald, 1901; and *Culex gelidus* Theobald, 1901, constituted 96 percent of the *Culex* collected. Other *Culex* species taken less frequently are listed in the order of frequency.

The high densities of *Culex tritaeniorhynchus* and *C. pipiens* are significant in that the species are known to be vectors of Japanese B encephalitis (Mackie, Hunter, and Worth, 1954), and the disease is known to occur in countries adjacent to Thailand. Virus of Japanese B encephalitis has been recovered recently from *C. gelidus* and *C. tritaeniorhynchus* in Malaya by personnel of the U. S. Army Medical Research Unit (McCrumb, Diercks, Pond, Keegan, and Barnett, 1954).

Aedes lineatopennis (Ludlow, 1905) represented 37 percent of the *Aedes* collected; *Aedes mediolineatus* (Theobald, 1901) 28 percent; *Aedes vexans* (Meigen, 1830) 20 percent and *Aedes albopictus* (Skuse, 1895) 9 percent. Other *Aedes* collected are listed in the order of abundance.

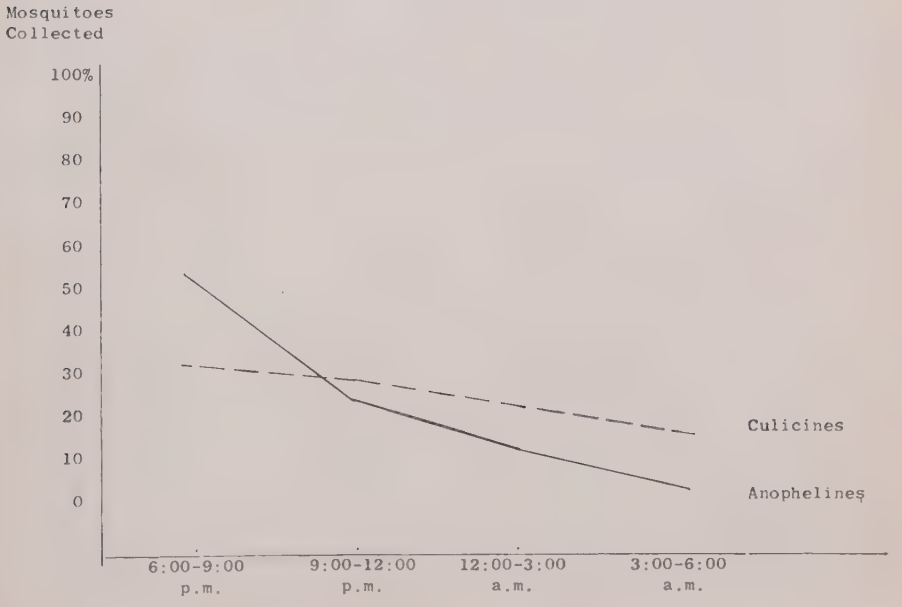
Figure 2:

Seasonal Distribution of Anophelines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953

Figure 3: Comparison of Nocturnal Flight Activities of Anophelines and Culicines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953



In the genus *Aedes* there are numerous species known to be vectors of yellow fever, dengue, and the encephalitides. *A. vexans* is reported as a vector for eastern equine encephalitis in the eastern United States (Doughty, 1953). *A. albopictus* is listed by Fergurson (1954) as a laboratory vector of western equine encephalomyelitis and St. Louis encephalitis.

Mansonia indiana Edwards 1930, *Mansonia annulifera* (Theobald, 1901), and *Mansonia uniformis* (Theobald, 1921) comprised 90 percent of the *Mansonia* captured. These three species are known to be vectors of filariasis in southern Thailand (Iyengar, 1953). Other *Mansonia* represented in the collections were: *Mansonia crassipes* (Van der Wulp, 1892); *Mansonia ochracea* (Theobald, 1903); and *Mansonia novochracea* (Barraud, 1927).

Armigeres obturbans (Walker, 1860) [=*subalbatus* (Coquillett, 1898)] represented 99 percent of the genus; with *Armigeres annulitarsis* Leicester, 1908, and *Armigeres malayi* (Theobald, 1901) being the other species recovered. *A. obturbans* is listed as a laboratory vector of St. Louis encephalitis and western equine encephalomyelitis (Fergurson, 1945), and with *A. malayi* as natural vectors of filariasis (Horsfall, 1955).

Ficalbia minima (Theobald, 1901), was the most abundant (49%) of the *Ficalbia*. Additional species collected are listed in the order of the number collected.

Uranotaenia campestris Leicester, 1908, was the species most often collected in this genus. *U. campestris* and *Uranotaenia edwardsi* Barraud, 1926, totalled 91 percent of the *Uranotaenia*. Other species were: *Uranotaenia recondita* Edwards, 1922; *Uranotaenia micans* Leicester, 1908; *Uranotaenia zelena* Barraud, 1934; and *Uranotaenia trilineata* Leicester, 1908.

Aedeomyia catasticta (Knab, 1909), and *Aedeomyia* spp.; *Harpagomyia genurostris* (Leicester, 1908); *Tripteroides* spp.; *Topomyia* spp.; and an undescribed genus were also collected. There are a number of specimens of the less common species awaiting additional detailed study for specific determination.

SPECIES OF MOSQUITOES CAPTURED (1952–1953). (Genera in alphabetic order, species in order of abundance captured).

**Aedeomyia catasticta* (Knab, 1909), *Aedeomyia* spp.

Aedes: lineatopennis (Ludlow, 1905), *mediolineatus* (Theobald, 1901), *vexans* (Meigen, 1830), *albopictus* (Skuse, 1895), **pallidostriatus* (Theobald, 1907), *caecus* (Theobald, 1901), **vallistris* Barraud, 1928; *uncus* (Theobald, 1901), **pulchritarsis* (Rondani, 1872), **stenoetrus* (Theobald, 1907).

Anopheles: vagus Dönitz, 1902; *philippinensis* Ludlow, 1902; *aconitus* Dönitz, 1902; *nigerrimus,* Giles, 1900, *sinensis* Wiedemann, 1828; *tessellatus* Theobald, 1901; *kochi* Dönitz, 1901; *barbirostris* Van der Wulp, 1884; *pallidus* Theobald, 1901; *ramsayi* Covell, 1927; *maculatus* Theobald, 1901; *barbumbrosus* Strickland and Chowdhury, 1927; *jeyporienensis candidensis* Koidzumi, 1924.

Armigeres: obturbans (Walker, 1860), [=*subalbatus* (Coquillett, 1898)], *annulitarsis* Leicester, 1908; *malayi* (Theobald, 1901).

Culex: fuscocephalus Theobald, 1907; *quinquefasciatus* Say, 1823; *pipiens* Linneaus, 1758; *tritaeniorhynchus* Giles, 1901; *gelidus* Theobald, 1901; *vishnui* Theobald, 1901; *bitaeniorhynchus* Giles, 1901; *whitmorei* (Giles, 1904), *fuscanus* Wiedemann, 1820; *Culex (Lophoceratomyia)* spp., *Culex (Lutzia)* spp., *Culex malayi* (Leicester, 1908), **fuscitarsis* Barraud, 1924; *halifaxi* Theobald, 1903; *rubithoracis* Leicester, 1908; *sinensis* Theobald, 1903.

Ficalbia: minima (Theobald, 1901), *luzonensis* (Ludlow, 1905). *hybrida* (Leicester, 1908), *chamberlaini* Ludlow, 1904; *fusca* (Leicester, 1908), **metallica* (Leicester, 1908), **aurea* (Leicester, 1908), *Ficalbia* sp.

Harpagomyia genurostris (Leicester, 1908).

* New occurrence record for the country.

Mansonia: indiana Edwards, 1930; *annulifera* (Theobald, 1901), *uniformis* (Theobald, 1921), *crassipes* (Van der Wulp, 1892), *ochracea* (Theobald, 1903), **novochracea* (Barraud, 1927).

**Topomyia* spp.

Tripteroides spp.

Uranotaenia: campestris Leicester, 1908; *edwardsi* Barraud, 1926; *recondita* Edwards, 1922; *micans* Leicester, 1908; **zelena* Barraud, 1934; **trilineata* Leicester, 1908.

The following species and the genus *Topomyia* represented in the light trap collections are additions to the reported mosquito fauna of Thailand: *Topomyia* spp., *Aedeomyia catasticta* (Knab, 1909), *Aedes pallidostriatus* (Theobald, 1907), *Aedes pulchitarsis* (Rondani, 1872), *Aedes stenoetrus* (Theobald, 1907), *Aedes vallistris* Barraud, 1928; *Culex fuscitarsis* Barraud, 1924; *Ficalbia metallica* (Leicester, 1908), *Ficalbia aurea* (Leicester, 1908), *Mansonia novochracea* (Barraud, 1927), *Uranotaenia trilineata* Leicester, 1908 and *Uranotaenia zelena* Barraud, 1934.

Summary. During the first year of operation of a light trap (New Jersey type) in the municipality of Chiengmai, Thailand, following one year of the expanded Thai malaria control operations using DDT residual house-spray, 28,962 mosquitoes were identified from 282 trap-night collections for the period between March, 1952–April, 1953.

Of the 18 genera and estimated 200 species of mosquitoes occurring in Thailand, 11 genera (60%) and 66 species (33%) were represented in the initial light trap collections in northern Thailand. Of these, one genus and 11 species from six genera constitute new occurrence records for the country. *Culex* spp. constituted 78 percent of the total collection: *Anopheles* spp., 18 percent. The most abundant *Anopheles* was *A. vagus* (37%), the only species collected during all the months of the year. *A. philippinensis, A. aconitus, A. nigerrimus,* and *A. sinensis* represented 58 percent of the *Anopheles*. The anophelines listed have been reported as natural or experimental vectors of malaria in countries of the Indo-Australian Region and the latter two have been reported to be vectors of filariasis in southern Thailand.

Anopheles minimus Theobald, 1901, the only known vector of malaria in northern Thailand, was not collected in trap, in house inspections, nor larval collections. Prior to malaria control measures beginning in 1951, *A. minimus* was abundant in the municipality of Chiengmai. The attractiveness of the New Jersey type light trap to this species in Thailand remains to be ascertained.

Among the most abundant *Culex* species were *C. tritaeniorhynchus, C. pipiens-quinquefasciatus,* and *C. gelidus,* vectors of Japanese B encephalitis. *Aedes vexans, Aedes albopictus,* and *Armigeres obturbans,* reported vectors of other encephalitides, were represented in the trap collections, as were *Armigeres malayi* and *A. obturbans,* vectors of filariasis in Ceylon and India. *Mansonia indiana, M. annulifera,* and *M. uniformis,* vectors of filariasis in southern Thailand, comprised 90 percent of the *Mansonia* collected. All other species collected are tabulated.

The anopheline and culicine populations increased with the progress of the rainy season (June–August) followed by a decline during the month of floods (September). The culicines continued to decline in density through the dry-cold season (November–January) while the anopheline density increased to a second and higher peak in November before a sharp decline during December and January.

Acknowledgments. The authors are indebted to Mr. Manop Rattanopradith, Technical Assistant, Thai Division of Malaria and Filariasis Control, for field and laboratory assistance; to Dr. Alan Stone, U. S. Department of Agriculture, for assisting with the completion of this study and for reviewing the manuscript; to Dr. Melvin E. Griffith and Mr. Robert E. Elbel, U. S. Operations Mission to Thailand, for reviewing the manuscript; and to Dr. William E. Bickley, University of

Maryland, and to Dr. Dale R. Lindsay, National Institutes of Health, PHS, for assistance with the completion of this study.

References Cited

1. BONNE-WEPSTER, J. and SWELLENGREBEL, N. H. 1953. The Anopheline Mosquitoes of the Indo-Australian Region. J. H. de Buzzy, Amsterdam, 504 pp.

2. CAUSEY, O. R. 1937. Some anopheline and culicine mosquitoes of Siam with remarks on malaria control in Bangkok. Amer. Jour. Hyg. 25(2):400–420.

3. DOUGHTY, FRANK M. 1953. Annual Report, Union County (New Jersey) Mosquito Extermination Commission, 12 pp.

4. FERGURSON, FREDERICK F. 1945. Biological Factors in the Transmission of Arthropod-Borne Virus Encephalitides. USPHS Monograph #23. Gov't. Print. Off., 37 pp.

5. GRIFFITH, MELVIN E. 1955. Personal Communication.

6. HORSFALL, W. R. 1955. Mosquitoes—Their Bionomics and Relation to Disease. Ronald Press, New York, 723 pp.

7. IYENGAR, M. O. T. 1953. Filariasis in Thailand. Bull. Wld. Hlth. Org., 9:731–766.

8. MACKIE, THOMAS T., HUNTER, GEORGE W., and WORTH, C. BROOKE. 1954. A Manual of Tropical Medicine. W. B. Saunders Co., 907 pp.

9. MCCRUMB, F. R. JR. 1955. Personal communication. McCrumb, F. R., Jr., Diercks, F. H., Pond, W. L., Keegan, H. L., and Barnett, H. C. in preparation (from Annual Report of the Institute for Medical Research, 1954).

10. SAMBASIVAN, G., BHATIA, M. L., PRANICH, U., and NOTANANDA, V. 1953. Report of Thai Govt./WHO/UNICEF Malaria Control Demonstration in Thailand. WHO/SEA Mal. 1–53–48. (mimeo.), 42 pp.

11. VEJJASASTRA, LUANG BHAYUNG. 1935. Files of Ministry of Public Health, Thailand. Personal communication.

OVIPOSITION SITE PREFERENCE OF *AEDES* MOSQUITOES (CULICIDAE) IN THE LABORATORY

W. E. BECKEL [1]

INTRODUCTION. The problem of what characteristics of the substrate influence the female mosquito when she is ready to oviposit is of practical importance in the field from the point of view of where to find the eggs, and in the laboratory, in the effort to obtain the most eggs from blood-fed females. Some work has been done on where the eggs are found in the field (1, 2, 3 and 5) but this only indicates where the eggs are when the sampling is done and although there is a good chance that this represents where they were laid, the possibility of translocation by rain to a site not chosen by the adult must be considered, as pointed out by Filsinger (3). Beckel and Barlow (1) showed that *Aedes communis* (De Geer) in the field did not lay randomly around the pools; also Bodman and Gannon found this to be true of *Aedes vexans* (Meigen) (2). In both cases only speculation could be made as to what caused the discrimination. Where exactly the eggs of *Aedes hexodontus* Dyar are found in the field has not been discovered since such work presents some difficulty owing to the vast areas of damp and marshy terrain available in the sub-Arctic and Arctic in which these mosquitoes might lay. However, experiments have been carried out to find some of the things which influence the adult female in the laboratory and from this the possible influence in the field may be inferred. No attempt was made to evaluate the variation in the chemical make-up of the water. This type of approach was made with *Anopheles quadrimaculatus* Say. (6) but the results were relatively inconclusive. In the experiment to be described below, only the effects of temperature, brightness of the substrate, and its physical consistency were evaluated.

[1] Defence Research Northern Laboratory, Fort Churchill, Manitoba.

Materials and Methods. *Aedes* females were given a blood meal from a guinea pig and caged in open mesh cages in the laboratory at 70° F. for from five to seven days. At the end of this time they were just about to lay their eggs. They were then transferred to the experimental conditions where the choice of substrates was offered. Within 12 to 24 hours some of the adults would commence to lay eggs and laying would be fairly well finished within 48 hours. The oviposition sites were removed after 72 hours and the number of eggs on each counted.

Oviposition Site Preference. Wire mesh cages 12 by 12 by 24 inches were placed at 70° F. under fluorescent lights so that the lighting inside the cages would be uniform. Two round apertures had been cut in the bottoms of each cage so that the aperture centers would be equidistant from the walls of the cage and from each other. The cages were raised enough from the table on which they rested so that two petri dishes could be placed in the apertures, fitting tightly and with their surfaces flush with the floor of the cage. Each petri dish was filled with absorbent cotton and kept constantly soaked with distilled water. The experimental substrates were then placed on the absorbent cotton. The adults were removed from their storage cages with an aspirator and introduced into the experimental cages. Sugars were offered as a supplementary food.

The following substrates were offered. Trial 1: white filter paper and black filter paper (painted with India ink). Trial 2: white filter paper and white terrycloth towelling. Trial 3: white towelling and black towelling (painted with India ink). Trial 4: black towelling and black filter paper.

Temperature Preference. A temperature gradient was set up to enable adults just about to lay, to choose, in total darkness, the temperature at which they preferred to lay their eggs. The gradient consisted of a glass tube six and one-half centimeters in diameter and 72 cm. in length with one end of the glass tube surrounded by water kept constant at some temperature between 33° to 40° F. and the other end surrounded by water kept constant at some temperature between 98° and 115° F. A non-linear gradient was established with temperatures ranging from 99° F. at the warm end to 44° F. at the cold end. On a thin strip of wood, one-quarter of an inch wide and the length of the gradient, were mounted 24 thermocouples, two in the center of each six centimeter length along the strip. Absorbent cotton and white cotton cloth were wrapped about the strip of wood so that the bottom thermocouple at each station was covered by the substrate and the top was in the air above the substrate. The cotton and cloth were then soaked with distilled water. The gradient was insulated and made light-proof. An observation window was made available on the top. Fifty blood-fed female *Aedes hexodontus,* ready to lay, were then introduced, 25 from each end of the gradient, at or about the center. Upon observation they were noted to fly and walk about readily. The thermocouples were then read each 24 hours for the 72-hour duration of the experiment. The experiment was repeated three times on each of two successive years. At the completion of each trial the number of eggs in each six centimeter region was counted. The gradient was found to vary little in temperature once it was allowed to come to equilibrium and no difference between the temperature of the substrate and the air above was recorded. The set of thermocouples in the air above the substrate was discontinued in the second year. The thermocouple readings chosen for statistical treatment were those taken at the period when it was considered, on the basis of adult age and observation, that most of the eggs were being laid.

Results and Discussion. *Aedes hexodontus* Dyar. The results of the oviposition site preference experiments are given in Table 1.

The choice of substrate may be made by the female either by sight or after she has made a tactile survey of the substrate. Also it may be neither of these but may

TABLE 1.—Preference for Brightness and Physical Consistency of Ovipositing *Aedes hexodontus* Females

(100 adults used in each trial)

Trial number	Type of substrate	Number of eggs 1953 Test 1	1954 Test 1	1954 Test 2
1	White filter paper	180	159	
	Black filter paper	275	216	
2	White filter paper	85	32	
	White towelling	887	925	
3	Black filter paper	574	11	69
	Black towelling	3807	842	896
4	White towelling	2202	140	192
	Black towelling	2717	904	1200

involve the awareness of a different humidity such as might exist over the towelling as a result of greater evaporating surface or an awareness of a difference in temperature. A complex interaction of all considerations may be the case. If the female must first touch the substrate before choosing, then she may lay some eggs on one substrate before being stimulated to move. Also the period between which the individual eggs mature and are ready for laying may be long enough that the female is stimulated to fly or walk from the original oviposition site and thus be forced to make a new choice of oviposition substrate each time she lays. Because of these considerations it was not possible to ascertain the number of females choosing one site or the other, therefore the absolute number of eggs laid on each substrate was used as indicative of preference. When this is done the preference for black over white as well as for towelling over filter paper is significant at the .005 level. Why there were fewer eggs laid when filter paper alone was offered as a substrate is not known.

It is probable that the choice of black over white is made by the adult after a visual survey. Frost (4) found a definitely greater attractiveness with black light over white of equal foot candles. In the present experiment the intensity of reflected light from the black and white substrates was not measured but our results agree with those of Frost in showing the preference for black. What specific stimulus of the many which are combined in the towelling, causes the female to choose to lay eggs on towelling rather than on filter paper is not known. The depressions into which the eggs are inserted on towelling are darker than the surface of the filter paper when both substrates are white but this is not the case when both are black. The dampness may be important in that more moisture would be held in the depressions of the towel than would be found on the surface of the filter paper. Yet water alone is not sufficient stimulus since *Aedes hexodontus* when offered a choice of open water and a wet towel never lays on the water. When the female lays she makes a probing and stroking movement with her abdomen so it appears that the abdominal area carries the organs sensitive to at least a part of the factors influencing oviposition.

In the experiment to test temperature, three trials each year were carried out in two successive years, 1953 and 1954. The data, each year, for all three trials showed normal distributions which were approximately superimposed. On the basis of this it can be assumed that the temperature at the mean of the frequency distribution represents the preferred temperature. To compute the mean of the frequency distribution for each year, 29 classes were extracted from the pooled frequency curve of the three trials and the group mean calculated. A "t" test confirmed that there were no significant differences between the three trials. The variance for the pooled trials for 1953 was 76.09, the standard deviation was 8.78; the mean of the frequency distribution of all eggs appeared at 73.97° F. For 1954 the variance was 30.85, the standard deviation 5.55; the mean frequency distribution was at 74.18° F. The fiducial interval of the mean at the .01 level of significance was 73.97 ± 0.422° F. for 1953 and 74.18 ± 0.229° F. for 1954. It was also calculated at the 0.95 level of confidence,

that 95 percent of the eggs of a similar experiment would be laid in a temperature range of 73.98±17.21° F. for 1953 and 74.18±10.88° F. for 1954. The confidence intervals for the mean show that close agreement exists in the preference of the sample of the populations from both years.

It was of interest that the mosquitoes laid a few eggs at both the gradient extremes of 99° F. and 44° F. If they react in the field as in the laboratory, a wide range of temperatures could be tolerated for oviposition.

Aedes aegypti Linnaeus. This species was used for oviposition site preference for comparison with the northern species. As shown in Table 2 the results again show

Table 2.—Oviposition Site Preference of *Aedes aegypti*

(100 Females used in each trial)

Trial number	Type of substrate	Number of eggs
1	White filter paper	65
	Black filter paper	2782
2	White filter paper	355
	White towelling	3525
3	Black filter paper	156
	Black towelling	1340
4	Black towelling	987
	White towelling	88

conclusively that black is preferred to white and rough to smooth.

Aedes campestris Dyar and Knab. An oviposition site preference experiment was also performed with *Aedes campestris*. The choice was between moist white filter paper and a dish of distilled water. The method used was similar to that used where the choice was white or black and rough or smooth. In the first trial with 75 adult females, 496 eggs were laid on white filter paper and 4,305 eggs on distilled water. In the second trial with 75 adults, 110 eggs were laid on white filter paper and 4,000 on distilled water.

The data show conclusively that *Aedes campestris* prefer to lay on open water rather than on a moist white substrate. It must be noted that no information was taken on the brightness of the surface of the water compared to that of the white filter paper but the dish of water was placed over a light background and on inspection gave light reflections.

Aedes communis De Geer. No controlled experiment was performed with *Aedes communis* to test oviposition site preference but during a large cage experiment, reported elsewhere, many eggs were found laid in damp dark corners of the cage. Only a few eggs were found on the dishes of white cloth covered absorbent cotton offered as oviposition sites.

Summary and Conclusions. 1. *Aedes hexodontus, Aedes aegypti* and *Aedes campestris* were tested for oviposition site preference. Black and white, and rough and smooth surfaces were offered to *hexodontus* and *aegypti,* open water and moist filter paper were offered *Aedes campestris.*

2. Black was conclusively chosen over white and rough over smooth for oviposition. *Aedes campestris* chose open water more often than moist filter paper.

3. *Aedes communis* in the laboratory cages was noted to choose damp dark areas in which to lay in preference to moist white cloth.

4. *Aedes hexodontus* showed a temperature preference for oviposition at 73.97± 0.422° F. one year and 74.18±0.229° F. another.

5. It appears that *Aedes hexodontus* could lay over a wide range of temperatures in the field as evidenced by the wide range of temperatures over which the eggs were laid in the laboratory but a preference might be shown for the temperatures mentioned in (4) above.

6. The data indicate that *Aedes hexodontus* and *Aedes aegypti* may prefer rough dark substrates to light colored smooth ones in the field. *Aedes campestris* may prefer open water to merely moist substrates.

Acknowledgements. The author wishes to acknowledge the valuable assistance of Mr. C. E. Law of the Operational Research Section of DRNL for carrying

out the statistical analysis, and to Mr. T. P. Copps for his usual high caliber technical assistance.

References

BECKEL, W. E., and BARLOW, C. A. 1954. Studies of the biology of the *Aedes* of northern Canada (Culicidae). III. Field oviposition of *Aedes communis* (De Geer) with a method of separating the eggs from the substrate. Defence Research Northern Laboratory, Technical Paper Number 8, Defence Research Board, Ottawa.

BODMAN, M. T., and GANNON, NORMAN. 1950. Some habitats of eggs of *Aedes vexans*. Jour. Econ. Ent. 43(4):547–548.

FILSINGER, CARL. 1940. Distribution of *Aedes vexans* eggs. Proc. 28th Ann. Meet. New Jersey Mosq. Exterm. Assoc. 28:12–19.

FROST, S. W. 1954. Response of insects to black and white light. Jour. Econ. Ent. 47(2): 275–278.

HUSBANDS, R. C. 1952. Some techniques used in a study of *Aedes* eggs in irrigated pastures in California. *Mosquito News* 12:3.

LUND, H. O. 1942. Studies on the choice of medium for oviposition by *Anopheles quadrimaculatus* Say. J. Nat. Mal. Soc. 1:101–111.

PREPARATION OF THE CHORION OF EGGS OF AEDINE MOSQUITOES FOR MICROSCOPY [1, 2]

GEORGE B. CRAIG, JR. [3]

Entomology Branch, Chemical Corps Medical Laboratories, Army Chemical Center, Md.

During recent years, there has been an increased interest in the bionomics of eggs of the *Aedes* group of mosquitoes. Mosquitoes of *Aedes, Psorophora* and related genera spend most of their lives in the egg stage. Survey procedures for locating eggs are being standardized, prehatching treatments for destroying eggs are being devised and physiological and embryological studies are being made. Workers have been hindered in these activities by inability to recognize the eggs that have been obtained in the field.

In connection with the general problem of identifying eggs of aedine mosquitoes, a method that permits rapid and accurate examination of egg shells has now been developed. This depends on the fact that the layers that comprise the shell of the egg of the mosquito bear distinctive surface features which are specific in many instances. Descriptions of eggs given by Goeldi (1905) and Mitchell (1907) called attention to some of these features. Later work on *Anopheles* showed differences even at subspecific levels (cf. Horsfall, 1955 for ref.). Howard *et al.* (1912) and James (1922) made further observations on the surface structures seen on whole eggs of aedine mosquitoes. Marshall (1938) noted that the eggs of *Aedes* could be determined by gross shape but did not study surface features. Horsfall *et al.* (1952) found that eggs of *Psorophora* bear distinctive markings that are visible for the most part by reflected light and are very distinct when fragments of chorion are examined by phase microscopy.

Former methods for preparing fragments of chorion for mounting on microscope slides have met with certain difficulties that have now been overcome to a large extent. The natural color of eggs of many species of *Aedes* and *Psorophora* is so dark that light can not pass through the shell. The untreated chorion is hard and brittle, shattering readily when pressed by the coverslip. Crushing the whole egg

[1] The author is indebted to Dr. William R. Horsfall and Dr. Dietrich Bodenstein for valuable suggestions in connection with this work.

[2] Portion of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Entomology at the University of Illinois.

[3] 2nd Lt., Medical Service Corps., U. S. Army

causes membranes and fat globules from the larva to adhere to the shell, even after considerable washing, and photomicrography is hindered by any foreign material. Also, former methods do not allow permanent mounting and storage. Lastly, the former methods required preparation of slides of a great many eggs in order to obtain a few slides that could be used. The present method avoids these difficulties.

Method. The gelatinous exochorion and any adherent debris are removed by rolling the egg between two moist pieces of filter paper. The pattern of the exochorion usually approximates that of the endochorion. However, in some species where the exochorion is particularly adhesive, the pattern of the endochorion may be obscured by sheets of exochorion. Most of the exochorion will come off in alcohol.

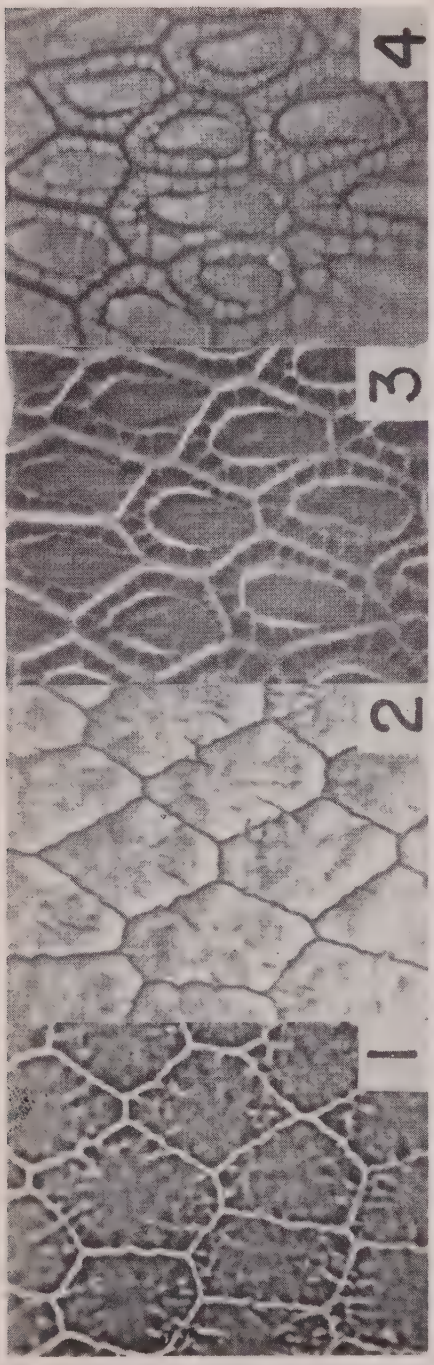
After the shell has been cleaned, the egg is placed in water in a deep flat-bottomed depression slide where preparations prior to mounting are carried out. The cap is removed from the anterior end of the shell and the larva and vitelline membrane are teased out with dissecting needles. If the bleaching operation is carried out while the larva is still in the shell, the bleaching proceeds very slowly and it becomes impossible to remove the shell contents. In living, freshly killed, or preserved eggs, the contents will tease out readily but when the egg has been dead for some time, most of the decomposed material must be squeezed out. This operation should not be carried out under alcohol because the vitelline membrane may then adhere to the inner surface of the endochorion. After dissection, the egg is placed in absolute alcohol and washed several times.

In order to remove the color and soften the rigid shell, the chorion must be bleached. This is done by a modification of Mayer's Chlorine Bleach (Gatenby and Beams, 1950). The Mayer method was used by Beckel, 1953, to study the embryology of eggs of *Aedes hexodontus*. Many other bleaching agents were tried, including aqua regia (De Coursey and Webster, 1952) and sodium hypochlorite (Mortenson, 1950). These were unsatisfactory because they removed the entire chorion or made it transparent so that the surface sculpturing was no longer visible.

For the bleaching operation, the alcohol is drawn off and some crystals of potassium chlorate (quantity is not important) are placed in the depression with the shell. Then concentrated hydrochloric acid is dropped on the crystals. The solution turns yellow and bubbles of free chlorine are given off. After a short time, the dark color is removed from the shell, which now appears translucent and light tan. Moreover, the shell loses its brittleness and inflexibility and becomes softer and more pliable. The shell can remain in this solution indefinitely without further change. If any dark color remains, more hydrochloric acid or potassium chlorate is added. Eggs differ according to species in the speed at which they are bleached. This is probably due to differences in the thickness of the shell. *Aedes atropalpus* and *A. aegypti* will bleach in 30 seconds or less while *Aedes triseriatus, A. stimulans* and *Psorophora ciliata* may take many minutes. Shells tend to float on top of the liquid. These will bleach but care must be taken to prevent them from being pushed out of solution by the bubbles.

Finally, the shell is cleaned of bleach by removing it from the bleaching solution to absolute alcohol. Transfers into or out of acid are made with a small wooden spatula or pointed wooden stick rather than a pipette. Fragments of crystals that may cling to the shell may be removed by immersing the shell in concentrated hydrochloric acid. Washing in several changes of absolute alcohol removes all acid.

The shell is mounted in euparal. The shell is transferred from the absolute alcohol with a drop of euparal on a dissecting needle and is placed in a drop of euparal on a slide. A No. 2 circular coverslip is placed on the drop and the coverslip is allowed to settle without pressure. Flat, single layers of chorion are obtained by sliding the coverslip back and forth with pressure around the egg



from the curved side of curved forceps. With practice, it is possible to flatten the shell and spread it into two single sheets.

MICROSCOPY. After the shell fragments have been mounted, the surface features may be examined with a standard or phase contrast microscope. The patterns on the eggs of most species of *Aedes* and *Psorophora* are entirely visible with a standard microscope under magnifications of 100× or less. However, for those species with faint patterns, the phase microscope is preferable, since it gives the impression of added depth and dimension to the surface features.

This method has been used for efficient identification of eggs of 15 species of *Aedes*. It has also been applied to eggs of 6 species of *Psorophora* with satisfactory results.

Plate I shows pieces of shell of eggs of *Psorophora* as observed by the phase contrast microscope. These pictures were taken with a Zeiss-Winkel attachment camera on Kodak M plates, using fine-grain developer. The prints were enlargements on high contrast paper. Magnification on the film was 420× through a 1.8 mm. objective and 10× occular.

SUMMARY. A method has been developed to examine the chorion of eggs of aedine mosquitoes by transmitted light. This entails removal of the larva from the shell, bleaching and softening the shell with potassium chlorate and hydrochloric acid, washing, mounting in euparal and breaking and separating the shell into flat, single sheets. The surface features of

PLATE I. Portions of bleached chorion of eggs of mosquitoes showing surface features by transmitted light as photographed with the phase contrast microscope. Position of fragments near anterior end of egg. Magnification 520 diameters.

Figure	Species	Phase contrast lighting
1	*Psorophora confinnis*	bright medium
2	*Psorophora confinnis*	dark low
3	*Psorophora varipes*	bright medium
4	*Psorophora varipes*	dark low

the shell of eggs of *Aedes* and *Psorophora* as observed by high power and transmitted light may indicate characters for classification of the eggs of these genera.

References

Beckel, W. E. 1953. Preparing mosquito eggs for embryological study. *Mosquito News*, 13(4):235–237.

DeCoursey, J. D., and Webster, A. P. 1952. A method of clearing the chorion of *Aedes sollicitans* (Walker) eggs and preliminary observations on their embryonic development. Ann. Ent. Soc. Amer., 45(4):625–632.

Gatenby, J. B., and Beams, H. W. 1950. The microtomist's vade-mecum. 11th Ed. Philadelphia, The Blakiston Company, xiv + 753 pp.

Goeldi, E. A. 1905. Os mosquitos no para. Mem. Mus. Goeldi., 4:154 pp.

Horsfall, W. R. 1955. Mosquitoes, their bionomics and relation to disease. New York, The Ronald Press Co., 732 pp.

Horsfall, W. R., Miles, R. C., and Sokatch, J. T. 1952. Eggs of floodwater mosquitoes. I. Species of *Psorophora*. Ann. Ent. Soc. Amer., 45(4):618–624.

Howard, L. O., Dyar, H. G., and Knab, F. 1917. The mosquitoes of North and Central America and the West Indies. Washington, D. C., Carnegie Inst. Publ. No. 159. Vol. IV, pp. 524–1064.

James, S. P. 1922. Notes on the eggs of culicine mosquitoes found in England. Trans. R. Soc. Trop. Med. Hyg., 16:267–269.

Marshall, J. F. 1938. The British mosquitoes. London, British Museum, xi + 341 pp. + 20 pls.

Mitchell, E. G. 1907. Mosquito life. New York, G. P. Putnam's Sons, xxii + 281 pp. + 8 pls.

Mortenson, E. W. 1950. The use of sodium hypochlorite to study *Aedes nigromaculis* (Ludlow) embryos (Diptera: Culicidae). *Mosquito News*, 10(4):211–212.

NOTES ON THE INFLUENCE OF SALT-MARSH TOPOGRAPHY ON TIDAL ACTION[1]

W. L. Bidlingmayer and J. W. Klock

Field observations of the effect of tidal inundation of several breeding areas of salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *Aedes sollicitans* (Walk.) in the Savannah, Georgia, area in 1952 suggested that tidal flooding was not always determinable by terrain elevation *per se* in relation to tidal levels. As a result, detailed observations were made on two salt-marsh areas on Little Tybee Island, Georgia, to observe the influence of a spring tide upon their inundation.

Little Tybee Island is a barrier island 2 miles long and less than 0.5 mile in width that lies about 1.5 miles behind the present coastline and is surrounded by extensive salt marshes. The island consists of a number of parallel sandy ridges which are separated by narrow sloughs, some of which extend the full length of the island. The vegetation of the ridges is composed primarily of pine and scrub palmetto associated with cabbage palms, cedar, and live oak. The lower reaches of the sloughs are dominated by a dense stand of *Spartina alterniflora* Lois, these plants being subjected to the daily ebb and flow of the tides. Farther up the sloughs dense stands of saltgrass, *Distichlis spicata* (L.) Beauv. frequently occur, while in the upper reaches the vegetation consists of freshwater species (e.g. *Mariscus jamaicensis* Crantz; *Hibiscus* sp.) which can probably tolerate a slight degree of salinity. The areas of the sloughs containing *D. spicata* frequently are good breeding sites for salt-marsh mosquitoes, particularly *A. taeniorhynchus* (Wied.). Two sloughs on this island were selected as sites for the tidal observations. The August spring tide studied was not as high as those that occur at other times of the year and thus may be considered more representative of the general tidal flows than would a spring tide

[1] From the Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

of maximum height (9.3 feet). The maximum predicted height of the August spring tide[2] for Petit Chou Island, the closest subordinate station listed in the Tide Tables, was 8.5 feet above mean low water on August 5, 1952 at 7:46 p.m. By midnight the water had dropped to a predicted height of only two feet above mean low water as determined from Table 3 in the Tide Tables.

Five tidal markers (A, B, C, D, and E, Figure 1) were placed in the ditches or waterways in the lower portions of several of the sloughs; tidal marker A being located in slough A, and tidal marker E located in slough E. A bench mark was established and the elevation of the tidal markers was determined from the bench mark.

One of the sloughs selected for study (E) was narrow with steep sides. At low tide it is dry and mosquito breeding has never been observed in it. In contrast, the second slough (A) was broad and flat and most of it was carpeted with *D. spicata*. Like several of the sloughs on the island, it was ditched many years ago, but the ditches have not been maintained and, at present, they probably are more beneficial than detrimental to mosquito breeding. Large broods of *A. taeniorhynchus* have been observed to emerge from this slough.

In each slough a series of small stakes was placed about 100 yards apart to observe the progress of tidal water (Figure 1). The relation of their heights to each other, or to mean low water, was not determined. As stake number 8 of both series was located where the slough was dry, a hole (approximately 21 inches deep) was dug within 5 feet of stake 8 one week before the test to detect any subterranean movement of the water. This site was numbered 8a.

The data from periodic observations of the tidal markers (A—E) are plotted in figure 2 for comparison with the predicted height of water at the nearby Petit Chou Island. These data show that the crest of the tide is lowered and delayed with increasing distances from Petit Chou Island.

The first observations of the stakes in sloughs E and A were begun at approximately 7:10 p.m. and repeated at 0.5 hour intervals thereafter for 5.5 hours. At slough E the first observations of stakes 1 and 2 showed a water depth of 15 inches and 14 inches respectively, the remaining part of the slough being dry. Slack water occurred during the following one-half hour period and then the tide ran out rapidly, the water dropping to a level of only 1 inch and 2 inches respectively at stakes 1 and 2 by 9:10 p.m. Although the water continued to flow out, its depth began to increase, reaching 9.5 inches by 12:40 a.m. at stake 1, and 8.0 inches at stake 2. Tide water first reached stake 3 at 8:40 p.m., and crested at 10:10 p.m. (10.5 inches). At stake 4 the tide entered at 9:10 p.m. and crested at 10:10 p.m. (7.5 inches). Stake 5 was flooded at 9:40 p.m. and a 6 inch crest recorded at 10:10 p.m. The water flowed to stake 6 at 10:10 p.m. and a 5.5 inch crest was reached at 10:40 p.m. At stakes 7 and 8 the water arrived at 11:10 p.m. and 11:40 p.m. respectively. The highest water levels recorded for these two stations were 6.5 inches and 2 inches respectively, at 12:40 a.m.

Following the tidal crest, the water at stake 3 dropped 7.5 inches by 12:40 a.m. while that at stakes 4, 5 and 6 dropped 3, 3 and 1.5 inches respectively. From the data presented for slough E, it appears that the peak of the tide sends a large mass of water moving up the sloughs. The progress of this mass is not rapid, and, as the height of the water in the Tybee River drops, water will flow simultaneously both forward and backward from a decreasing crest as it penetrates the slough. At stakes 1 and 2 in slough E, the water ran out rapidly after the change in the tide, but as the flood above it began to ebb, the depth of the water again increased. There was

[2] According to Tide Tables, East Coast, North and South America, 1952, U. S. Department of Commerce Coast and Geodetic Survey.

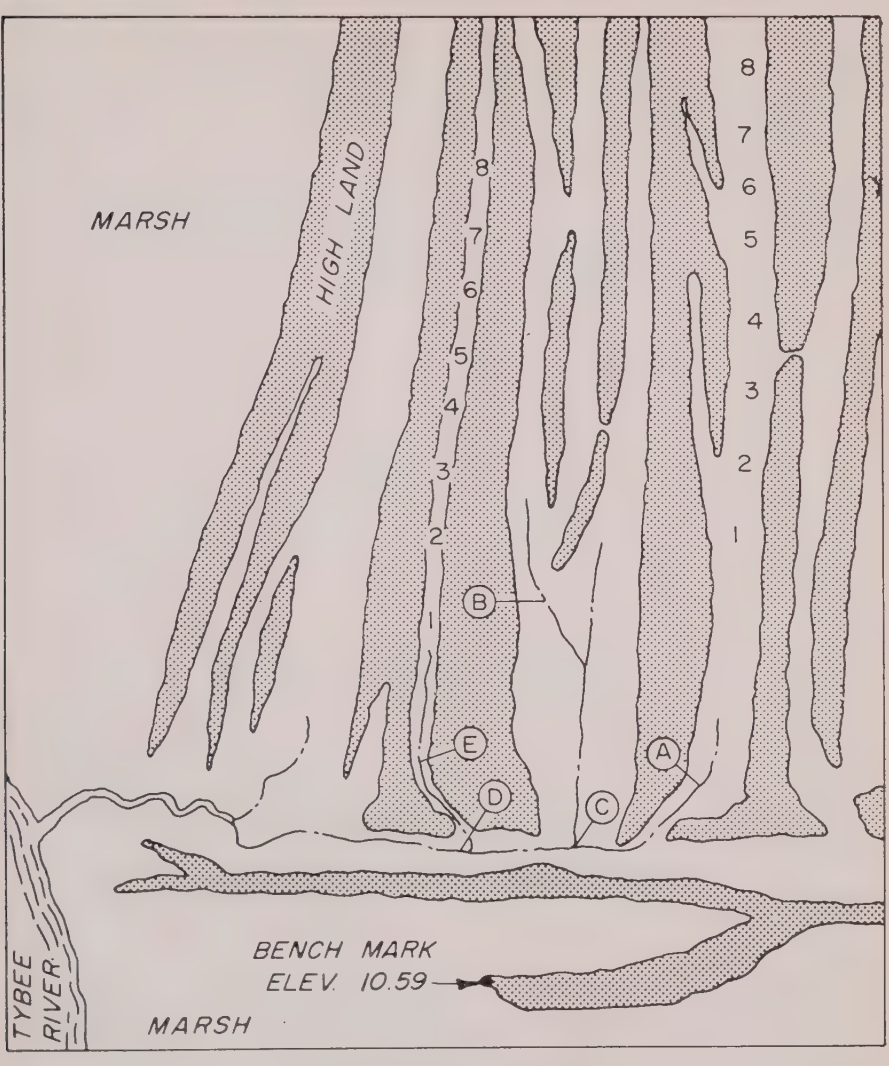


FIGURE 1

LOCATION OF TIDAL MARKERS AND ELEVATION STAKES ON LITTLE TYBEE ISLAND, GEORGIA

no fluctuation of the subsurface water level at stake 8a.

Unlike slough E, stakes 1 to 7 inclusive in slough A were in shallow water (2.1–8.0 inches) at the time observations began. The progress of the spring tide up this slough was noted by recording the increase in depth of water at the stakes. At stake 1 the depth began to increase at 8:10 p.m. and the crest occurred at 11:10

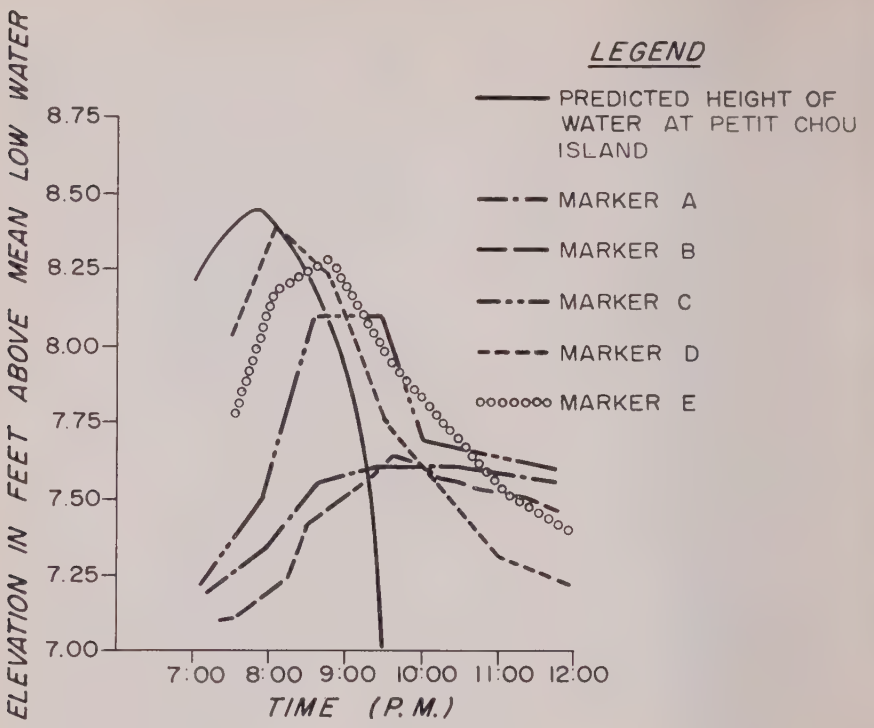


FIGURE 2

HEIGHT OF WATER AT TIDAL MARKERS IN SLOUGHS ON LITTLE TYBEE ISLAND, BETWEEN 7:00 P.M. AND 12:00 P.M. ON AUGUST 5, 1952, COMPARED WITH THE PREDICTED WATER LEVELS AT PETIT CHOU ISLAND

p.m. Stake 2 received tide water at 9:10 p.m. and the crest was recorded at 11:40 p.m. Tide water reached stake 3 at 9:40 p.m. and the crest occurred at 12:10 a.m. At stakes 4, 5, 6, 7 and 8 the tide water entered at 10:10 p.m., 10:40 p.m., 10:40 p.m., 11:40 p.m. and 12:40 a.m. respectively; the water depth continuing to increase at these stakes at the time when the last readings were taken at 12:40 a.m. At stakes 1, 2 and 3 the water level increased 4.1, 3.3 and 3.0 inches respectively. There were slight decreases following the crest probably due to the absorption of the water by the soil. The water level at stake 8a fluctuated slightly and increased 0.5 inches. No surface water reached stake 8a.

Slough A reflected the same delay both in time and height of the tide as did slough E and the 5 tidal markers.

These observations indicate the importance of certain hydraulic factors in investigations on the relationships of marsh flora, salt marsh mosquito production areas, and tidal flooding. Because of hydraulic friction and tidal phenomena, tidal levels in remote areas may be lower than in the main tidal streams under certain

conditions. Thus it is possible for vegetation (i.e. *D. spicata*) and mosquito production to occur at lower elevations in these remote areas than it would be in areas which are more accessible to tidal water.

The fact that the evaluation of mosquito production potentialities by use of physical indexes may be complex in character, further emphasizes the value and significance of vegetation as a general indicator of mosquito breeding sources.

Summary. Observation of tidal action in sloughs on Little Tybee Island, Georgia indicate that elevation levels alone are not infallible indicators of the frequency or extent of tidal flooding in an area. Hydraulic action and marsh flora are factors of importance in influencing mosquito production at the same or different elevations.

THE DISCOVERY OF *CULEX ERYTHROTHORAX* DYAR IN TEXAS

G. C. MENZIES,[1] R. B. EADS,[1] and F. C. HARMSTON [2]

Culex erythrothorax Dyar was found for the first time in Texas during intensive mosquito collecting in the western part of the State in 1953 and 1954. The collecting was done in an irrigated area of the Southern High Plains in connection with encephalitis and irrigation-mosquito studies conducted jointly by the Communicable Disease Center, U. S. Public Health Service, and the Texas State Department of Health. During the two years, approximately 400,000 mosquitoes, representing 6 genera and 18 species, were taken in the light trap and evening biting collections. Among these mosquitoes were specimens of a golden-brown, dark-legged *Culex* which appeared distinct from all the species previously reported from Texas. The male genitalia of these *Culex* were comparable to those of specimens of *C. erythrothorax* Dyar furnished by the Bureau of Vector Control, California State Department of Public Health. Dr. Alan Stone, U. S. National Museum, who examined genitalia slides of the west Texas specimens, also identified the species as *C. erythrothorax*.

C. erythrothorax was represented in the light trap material by a total of 84 adult specimens (Table 1). It was not present in the light trap collections taken at Hale Center, Hereford, and Kress in 1954, but one female was taken in a light trap at Abernathy on September 3 of that year.

In 1953, between August 5 and October 13, 12 *C.erythrothorax* were taken in twelve 15-minute biting collections at Lubbock, and 2 specimens were taken in ten 15-minute biting periods at Plainview. In 1954, only one *C. erythrothorax* was taken in ninety-eight 15-minute biting collections, all made in Plainview and vicinity.

In 1953, 8,000 fourth-instar larvae were identified from collections made in various habitats in the vicinity of Lubbock and Plainview. Among these larvae were 2 of *C. erythrothorax,* both collected on October 21 from permanent seepage pools along Yellow House Creek, near the eastern

[1] Texas State Department of Health, Austin, Texas.

[2] Logan Field Station Section, Communicable Disease Center, U. S. Public Health Service, Logan, Utah.

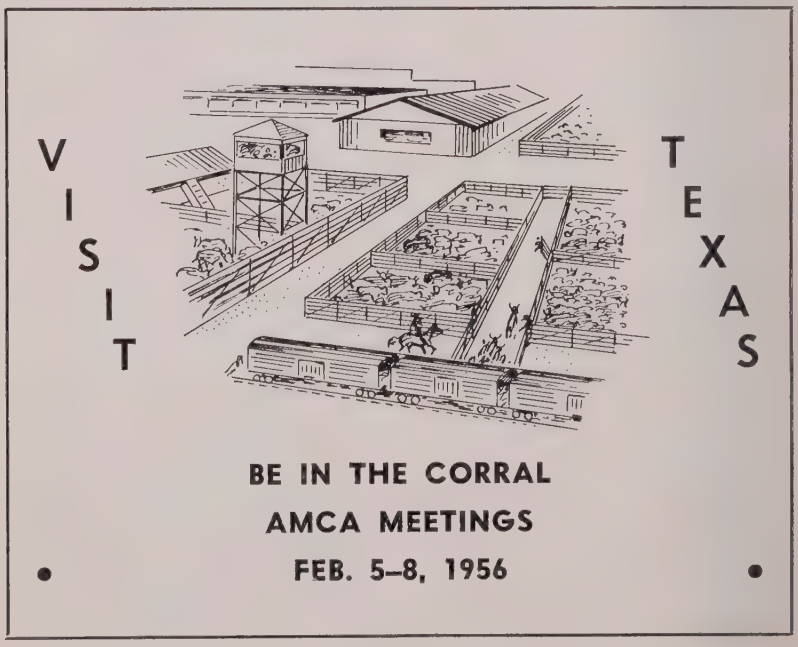
TABLE 1.—Light Trap Collections of *C. erythrothorax*

Locality	Year	Males	Females	Inclusive dates	No. of light traps	Periods of trap operation
Lubbock	1953	10	19	8/ 8–10/13	3	8/ 4–10/31
Lubbock	1954	9	13	6/27–10/ 4	1	4/26–10/28
Plainview	1953	2	18	8/ 9–10/17	2	8/ 4–10/31
Plainview	1954	4	9	5/ 8–10/18	5	4/27–10/28

outskirts of Lubbock. This breeding place, which contained luxuriant growths of both *Typha* and *Scirpus,* was located immediately adjacent to the site at which the biting collections in Lubbock were made. No larva of *C. erythrothorax* was found in the 1954 collections, which included 36,000 fourth-instar larvae from representative habitats in Plainview and vicinity, and 6,000 from Hereford and vicinity.

C. erythrothorax is reported from several localities in California by Freeborn and Bohart (1951, Bull. Calif. Insect Survey 1(2): 56), who also cite records from Mexico, Idaho, Nevada, and Utah. The west Texas collections therefore represent a considerable eastward extension of the known range in the United States.

SUMMARY AND CONCLUSION. *Culex erythrothorax* Dyar is reported for the first time from Texas. In view of the extensive mosquito collections made in west Texas during 1953 and 1954, and the small numbers of *Culex erythrothorax* taken, it appears that this species is rare in that area.



ASSOCIATION NEWS

TENTATIVE SCHEDULE OF THE ANNUAL MEETING OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION TO BE HELD AT THE HOTEL BEAUMONT, BEAUMONT, TEXAS, FEBRUARY 5–8, 1956

NOTICE

Due to space limitations there will be room only for the National Officers of the A.M.C.A. at the Hotel Beaumont. Reservations for other members should be made at the LaSalle Hotel, two blocks distant.

Sunday, February 5

1:00 p.m.	A.M.C.A. Board of Directors Meeting.
2:00–5:00 p.m.	A.M.C.A. Registration.

Monday, February 6

8:30–9:30 a.m.	A.M.C.A. Registration.
9:00–12:00 a.m.	Paper Reading Session.
12:00 Noon	Report of Nominating Committee.
1:30–5:00 p.m.	Paper Reading Session.
6:00–7:00 p.m.	Hospitality Hour.
7:00 p.m.	Banquet and Dance.

Tuesday, February, 7

9:00–12:00 a.m.	Paper Reading Session.
1:30–3:30 p.m.	Paper Reading Session.
3:30 p.m.	Business Session of the A.M.C.A.
8:00 p.m.	Evening Session, if necessary.

Wednesday, February, 8

Field Trip to Galveston

(Under the direction of Dr. Don W. Micks—University of Texas, Medical Branch)

8:30 a.m. Leave Beaumont by bus and proceed through the coastal plain country, approximately sixty miles at an altitude of from sea level to as much as two feet above.

Luncheon will be at the LaMarque Country Club, with a highly qualified and interesting speaker. Following the luncheon, trips into other sections of the control district, the University of Texas, Medical Branch or other points of interest may be taken by the visitor.

HOSPITALITY NOTE

The Beaumont Falstaff Distributor, Beaumont, Texas, cordially invites all A.M.C.A. members to stop in at their Hospitality Suite. The Hospitality room will be open throughout the entire conference, except during business sessions.

OF INTEREST TO THE LADIES

The Texas Company (Texaco oil & gasoline) has extended an invitation to all ladies in attendance at the A.M.C.A. meetings to come aboard their yacht, the "Ava," on Tuesday, February 7th, 1956, for a trip from Beaumont to Port Arthur, via the Neches River, Sabine-Neches ship canal and the Intra-Coastal canal. This trip is a topnotch attraction, and to be a guest on the "Ava" is a special privilege.

RESERVATION NOTES

BEAUMONT, TEXAS, FEBRUARY, 5–6–7, 1956

LaSalle Hotel—800 Pearl Street
Single $4.50–$8.00
Double $6.50–$10.50

Castle Motel—1125 No. 11th Street
(on Highways 69–90–96 and 287)
Single $6.00 $8.00
Double $9.00–$12.00

GALVESTON, TEXAS, FEBRUARY 8, 1956
Buccaneer Hotel, on the beach

A REQUEST FOR PHOTOS OF YOUR EQUIPMENT!

Mr. Fred H. Stutz, President-elect and Chairman of the Program Committee, has set aside 40 minutes at the coming annual meeting in Beaumont, Texas, for a showing of photographs in the form of 2″ × 2″ slides of equipment in use by mosquito control agencies in their "source reduction" programs. Such items as crane excavators, ditching plows or other ditching machines, earth movers, engineering equipment, etc., would be included. Standard, commercially available equipment would be appropriate, and it is especially desired that there be complete representation of custom-made or locally built and modified equipment that has been adapted for mosquito control. There are many such units in use, which reflect the originality and ingenuity of mosquito workers in meeting their individual problems, and it is hoped that this portion of the program will bring these good developments to the attention of other agencies which have similar needs.

It is hoped that many of the agencies which submit photos will also have representatives at the meeting, in which case these representatives will be asked to discuss briefly their own equipment items.

Your cooperation in submitting photos can make this part of the program a success. If a member has slides, but cannot be present, and is willing to send them in for showing, they should be sent to Thomas D. Mulhern, 5545 East Shields Avenue, Fresno 27, California, provided they can reach him before February 1. If there is any doubt as to their arrival by that time, they should be sent in his name directly to the Hotel Beaumont, Beaumont, Texas.

PAPERS LISTED FOR THE PROGRAM OF THE 12th ANNUAL MEETING OF THE AMCA, BEAUMONT, TEXAS, FEBRUARY 5–8, 1956 *

The Pest Mosquito Problem and its Relation to Public Heath. Samuel W. Simmons and George R. Hayes, Jr.

Symposium on Texas Mosquitoes: History of *Aedes aegypti* Control Work in Texas, A. C. Chandler; Texas Mosquito-borne Diseases, J. V. Irons; Some New Approaches to Mosquito Taxonomy, D. W. Micks; Mosquito Species Peculiar to Texas and Adjacent Areas, O. P. Breland; Texas Methods of Organization and Financing Mosquito Control Work, Wm. Harris Bell; Texas Problems from a Species Standpoint, R. B. Eads; Role of the State Department of Health in Mosquito Control, F. J. Von Zuben.

The Need for Standardization in Mosquito Control Operations, Charles F. Scheel.

State Reports: Illinois, William R. Horsfall; North Carolina, Charles M. White; Alabama, Arthur N. Beck and W. H. Kittrell; New England, Joseph F. Pannone; Louisiana, A. B. Ritter; Texas Gulf Association.

Chemical Control of Mosquitoes in Wilderness Areas. A. W. A. Brown.

Field Tests with Two Phosphorothioates Against Resistant Salt-Marsh Mosquitoes. J. B. Gahan, J. H. Bertholf, A. N. Davis, Jr., Carroll N. Smith.

Phosphate Use in California Mosquito Control. John O. Stivers.

Granular Pesticides in California Mosquito Control. G. Edwin Washburn.

Studies on the Vapour Toxicity, Repellency, the Residual Activity of DDT, Chlordane, Lindane and Dieldrin. E. Bordas and L. Navarro.

The Challenge of Global Malaria Eradication. Donald R. Johnson.

Dispersal of Mosquitoes Through Transportation, with Special Reference to Immature Stages. John H. Hughes and John E. Porter.

Progress and Problems of Interest to Mosquito Workers. E. F. Knipling.

Florida's New Entomological Research Center. Maurice W. Provost.

Mosquito Control Training Activities of the Communicable Disease Center. Harry D. Pratt.

Hatching Factors in Salt-Marsh *Aedes*. James S. Haeger.

Field Tests of Avian Host Preference in *Culex tarsalis* Coq. Richard P. Dow, W. C. Reeves, R. E. Bellamy.

Investigations of a Recurrent Flight Pattern of Flood Water *Aedes* Mosquitoes in Kern County, California. Gordon F. Smith, A. F. Geib, Lewis W. Isaak.

The Management of Water in the Coastal Marshes for Mosquito Control. John A. Mulrennan.

Mosquito Problems Associated with the Development and Utilization of Water Resources. M. B. Rainey and A. D. Hess.

Irrigation Efficiency and Mosquito Production. Lloyd E. Myers, Jr.

Pictorial Review of Source Reduction Equipment. Thomas D. Mulhern.

Organized Mosquito Control (film) Communicable Disease Center, USPHS, State of Florida. Dr. Simmons.

* A partial listing of titles, which were received too late for inclusion of details on time of presentation of each paper.

Eradication of the *Aedes aegypti* Mosquito from the Americas. Technical Evolution of the Campaign. Octavio Pinto Severo.

Investigation of the Biology and Control of Midges in Florida. D. B. Lieux and J. A. Mulrennan.

A New Species of *Aedes* from Jamaica, B.W.I. George A. Thompson.

Some Effects of Screens and Screen Treatments in Retarding the Entry of the Salt-Marsh Sandfly, *Culicoides furens* (Poey). John E. Porter.

Air and Insect Penetration of Insect Screens. Carl Wesley, Jr.

Effects of Various Insecticide Solutions on Different Kinds of Insect Screens. Carl Wesley, Jr.

A CORRECTION

FRANCISCO DY writes to make the modest assertion that we somewhat overtitled him in our WHO'S WHO IN AMCA, last issue. His proper title is Regional Malaria Adviser, not Director of the Regional Office, of WHO. Energetic Dr. Dy also reports, a bit breathlessly, that he rushed about over Vietnam, Laos and Cambodia, in the footsteps of Uncle Harry Stage but never did catch sight of him, though he finally learned he was actually in Hue, just below the border of North Vietnam. "Harry certainly gets around, doesn't he?" he adds. They may be able to get together in Phnom-Penh, Cambodia on January 10 to 15, 1956, when a meeting of representatives of the Ministries of Health of the three Indo-Chinese countries and perhaps Thailand, will meet with WHO and U. S. TCA representatives to coordinate their campaigns. We are promised a report on their progress and plans.—A. W. M.

FROM A LETTER TO THE EDITOR

Regarding *Mosquito News* and the printing of articles on field work: Lew Wells has been using DDT-plaster of paris bricks made in muffin baking tins. He uses them for rock pools in the coastal ledges where *Aedes atropalpus* breeds. With an accurate right arm he can hit pools that are difficult to climb to. Another item—we use "NICOFUME" nicotine smoke cans for *Culex* in underground storm drains. It's a lot less expensive than having a fogging unit parked over a manhole for a quarter or a half hour. Another item—the commercial truck bodies with outboard steel compartments are fine for keeping lunch boxes, clothing and small tools away from insecticide tanks and heavy tools carried in the truck body. These compartments are made by several companies; e.g. Holan and also Gar Wood.

Another subject about which most any mosquito district is vitally interested is the disposal of municipal garbage and rubbish. We all have our dumps and piggeries. Many a city is studying the question of incinerators because of lack of space for land fills. These are wasteful. Some cities in Europe and Asia compost garbage and rubbish successfully. You have no doubt followed work at the University of California on the experiments with compost. I'd like to see one of our eastern cities try it.—R. L. Armstrong, Supt., East Middlesex Mosquito Control Project, Cambridge, Mass.

NEWS AND NOTES

EPN Kills Larvae of *Culex pipiens*. At a canning factory near Westminster, Maryland a pond which was built to receive waste water provides ideal conditions for the breeding of *Culex pipiens*. Such large numbers of mosquitoes are produced that vast swarms are present in areas adjacent to the pond, and there is evidence to indicate that females fly as far as a mile in search of blood. The pond is heavily polluted with vegetable waste, and no fish are present. Sodium nitrate is added to accelerate decomposition of organic matter.

On August 30, 1955 the pond was treated with 25 percent EPN (Ethyl p. nitrophenyl thionobenzene phosphonate) wettable powder at the rate of about one-third pound per acre. The area of the pond is estimated to be between eight and nine acres, and 3 lbs. of the wettable powder were applied in 125 gallons of water at a pressure of about 200 lbs. Just prior to the application the population averaged 75 larvae per dip. Three hours after spraying there was an average of 0.2 larvae per dip. Enormous numbers of dead larvae were dipped.

Sampling of the larval population nine days after treatment showed an average of three small larvae per dip; after thirteen days there were very few pupae. The conclusion was that the EPN treatment was superior to treatments with DDT applied at the rate of 5 gallons of 30 percent emulsifiable concentrate in 125 gallons of water. The larval population seemed to build up more slowly after the EPN treatment. Furthermore, the treatment was less expensive than an application of DDT.—William E. Bickley.

Mosquito Control Progresses! District is Approved! Association is Formed! Brazoria County, Texas, citizens approved by a vote of more than two-to-one on April 25, 1955, the establishment of a Mosquito Control District in their county, according to information received recently from Mr. Oliver Osborn of the Health and Sanitation Committee of the Brazoria County Chamber of Commerce.

After establishment of the Mosquito Control District, the Brazoria County Commissioners Court planned to appoint a five-man board as governing body of the district. This will consist of one man from each precinct in the district and one member-at-large. It will then be the responsibility of the board to appoint a general manager and an entomologist to co-ordinate and advise the board about the mosquito control program.

In addition, the Gulf Coast Mosquito Control Association has been formed. This group is under the chairmanship of Judge Charles Grooms of Orange County. Membership is composed of the County Judges of Galveston, Jefferson, Chambers, and Brazoria Counties. The group was formed to establish better methods of obtaining and disseminating technical information on mosquito control and evaluating the possibilities of securing federal aid in conducting mosquito control research in the coastal counties. AMCA members who have assisted in an advisory capacity are Dr. A. W. Lindquist and Dr. F. C. Bishopp.

AMCA congratulates the sponsors of these new groups and hopes that the work will get off to a good start. Invitations to join the AMCA have been extended to these Texans. We shall welcome them to the 1956 meeting in Beaumont.—Ernestine B. Thurman.

We Have Had Members Flying Around All Over during these closing months of 1955. Roy F. Fritz has gone as Malariologist Consultant with ICA to the Mexican Government in connection with an ambitious program to eradicate malaria in the Western Hemisphere. This will be a two-year assignment and his address will be USOM Mexico IIAA, % State Department Mail Room, Washington 25, D.C. Roy recently returned from a one month assignment to Liberia. He is now a Senior Sanitary Engineer (Lt. Col.), by the way.

Meanwhile Don Pletsch has returned from the WHO Malaria Team in Taiwan and is again domiciled at Route 1 (Idylwood), Falls Church, Virginia. This does not mean that Don is *in* Falls Church. As this is written at least, he is in Mexico City with Roy helping to lay the groundwork of that important project.

Dr. Fred Bishopp also has returned to his old haunts after making a brief detour to California to visit his daughter. He is now living at 8014 Piney Branch Road, Silver Springs, Maryland, and says he is busy on projects of his own, for a change. Nevertheless, Washington mosquito control experts are glad to have him once more closer at hand.

Other Members and Friends of Members Now Visiting Afield include Paul L. Rice, who has taken a leave of absence from Whittier College to become Malaria Project Leader in Addis Ababa, Ethiopia. John E. Lane will be the assistant entomologist there, and Mr. A. E. Najjar, the parasitologist. Dr. Ingco, assistant to Dr. Antonio Ejercito in the Philippines, is in this country at the University of Florida.

Rollie Dorer Sends in a Brief Description of a Handy Little Rig for Light Trappers:

"The Virginia State Health Department's Bureau of Insect and Rodent Control processes and identifies many thousands of mosquitoes each season from the light traps operated in the Tidewater area.

"When a light trap takes a large number of moths and similar insects, it usually happens that when the mosquitoes are separated from the rest of the catch, their legs and bodies are so heavily coated with the powdery scales of the other insects that identification under the microscope is slowed down. In an effort to improve such conditions, this Bureau uses a rather simple 'air bath' that is quite effective. Ordinarily, a 50 cc., large mouth, 'sample bottle' is used but a larger size may be substituted. Through the cork stopper a hole is drilled near one edge with the blade of a small jack knife. The hole is set at a slight angle with the vertical and a glass 'intake' tube is inserted. A second, or 'exit' hole is then bored through the cork stopper and a tiny piece of fine mesh wire screen is cemented over it at the end opening into the bottle.

"Mosquitoes to be identified are placed in the bottle; blowing steadily for perhaps a second through the glass intake tube spins the insects about and cleans them thoroughly without injuring them; while the dust particles pass out the exit hole. The operation has been found to be quick, simple and effective and has been a great saver of time and eye strain in the task of identification.

"Many readers undoubtedly have used the same or similar equipment for this purpose but this is written for the benefit of those possibly inconvenienced by the same conditions and who have not yet got around to remedying them in a simple way.—Submitted by, George R. McPherrin, Bureau of Insect and Rodent Control, Virginia State Health Department."

TED AARONS, who resigned as assistant manager of the Alameda County Mosquito Abatement District at the time Harold Gray retired as manager, has taken over the directorship of the Diabolo Animal Laboratories. This is a Berkeley, California, firm specializing in the development of pedigreed strains of laboratory animals, used principally in cancer research. However, Ted still maintains an active interest in mosquito control, as is indicated by his retaining his membership in the American Mosquito Control Association and the California Mosquito Control Association. He writes that his address is now 290 Livorna Heights Road, Walnut Creek, California, which makes him a neighbor of Helen Louise Durkee.

RUSS FONTAINE, OF CALIFORNIA'S STATE DEPARTMENT OF PUBLIC HEALTH, HAS AN ARTICLE IN THAT DEPARTMENT'S EXCELLENT MAGAZINE "VECTOR VIEWS," which is too long for review here but contains so much valuable information that it should be read by all mosquito control men. Appearing in the August issue, Vol. 2, No. 8, the article is entitled, "Relation of California's M.A.D. Programs to the Effects of Pesticide Use Upon Livestock." In it, Russ reviews the history of insecticides and the ever-intensifying programs in the mosquito abatement districts, and then goes on to say, "Despite these increased hazards, there were no proved incidents of livestock poisoning traceable to M.A.D. operations. In only three instances, two involving livestock and one, geese, was there any doubt concerning M.A.D. operations. . . . In view of a recent statement by Dr. Radeleff, U. S. Department of Agriculture veterinarian at Kerrville, Texas, to the effect that geese are particularly susceptible to Toxaphene poisoning, it is possible that M.A.D. operations may have been directly responsible [for the geese]. . . . In summary it seems evident that while the potential for outbreaks of livestock poisoning resulting from M.A.D. operations appears to be very good, the likelihood of problems arising are fairly remote . . . ."

FRED SOPER MADE HEADLINES IN AN ASSOCIATED PRESS DISPATCH WHICH APPEARED IN NEWSPAPERS THROUGHOUT THE COUNTRY. Under the head "Malaria Extinction Cost Put at 100 Million," it appeared in Atlanta, Georgia, papers (where ye Ed. was) as follows: "The eradication of malaria in the Americas over the next four or five years would cost an estimated 100 million dollars, the director of the Pan American Sanitary Bureau estimates. Dr. Fred L. Soper made the statement at the eighth meeting of the bureau's directing council. The organization's 1956 budget calls for only $100,000 for malaria control." (That wouldn't pay for much TV time, would it? But TV goes on all the time, day and night. Well, so does mosquito control if less expensively. Useful, too.)

AFTER NOTING THE PAPER TO BE PRESENTED AT THE CINCINNATI MEETINGS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA by Dr. Max Day on the subject of myxomatosis in Australia, we find a note on the same disease in the October issue of California *Vector Views*. Among other things the article informs us that "The virus causing myxomatosis in rabbits is almost host specific. It not only will cause no ill effects in other animals, but will not seriously affect rabbits other than *Oryctilagus*. This is the common wild European rabbit. . . . It is the ancestor of all breeds of laboratory and most domestic rabbits." *Vector Views* goes on to remark that of course California rabbits are a different breed but *Views* has to admit that California rabbits can act as a reservoir from which mosquitoes may transmit myxomatosis to domestic rabbits. This makes the disease of interest to mosquito control men, now that self-appointed public benefactors have taken to liberating the disease here, there and everywhere.

TRAINING PROGRAM FOR MOSQUITO CONTROL SPECIALISTS: A training program for supervisors and foremen of mosquito control projects was

Some of the participants in training program at University of Massachusetts.

held from May 9–13 at the University of Massachusetts, Amherst, Massachusetts. This course was sponsored jointly by the Northeastern Mosquito Control Association, the New England Field Training Station (operated by the U. S. Public Health Service and the Massachusetts Department of Public Health) and the University of Massachusetts.

The course was conducted by Dr. H. D. Pratt, Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia. Mr. Robert Armstrong, Secretary of the Northeastern Mosquito Control Association, coordinated the arrangements for the supervisors of the various projects. Dr. F. R. Shaw was in charge of local arrangements at the University.

The meetings were well supported. The supervisors of the various projects including R. L. Armstrong, Lewis Wells, and Bill Doane not only participated in the program but also made possible the attendance of their foremen. The discussions were intentionally informal and each man was invited to enter into the discussion. As a result there was a free interchange of ideas.

In addition to those already listed, featured speakers included Dr. E. H. Wheeler, William Boyd, Dr. T. J. Andrews, and Dr. Marion Smith. Edward Wright, Chairman of the State Reclamation Board also attended a portion of one morning session.

The program in general consisted of lectures, discussions and films in the morning and laboratory periods in the afternoon. In the laboratory the recognition of both larval and adult mosquitoes was stressed. Demonstrations of the use of various types of equipment, and of the mixing of insecticides were held. One afternoon was spent in a field trip to show the relationship of the mosquito breeding areas to the type of mosquitoes produced.

The entire program was a success. The foremen indicated their satisfaction and expressed the hope that similar meetings could be held in the future.—Frank Shaw.

We Are Indebted to the Virginia Mosquito Control Association's "Skeeter" for so Much Information that it is Hard to Choose the Morsels to Repeat Here. However, two small items of equipment described in the August issue seem to be of potential value to all mosquito controllers. In connection with the installation of blinker lights atop fogging trucks and jeeps, which many districts are finding wise, Superintendent Carter of the Virginia Beach Control Commission reports an idea to save these lights from being knocked out of action by the first bough. Superintendent Carter bent two pieces of quarter inch steel bar into arcs which stood higher than the blinker and then fastened them to the cab roof like croquet wickets on each side of the light, pointing fore and aft. By this means he was able to give the light full protection and still not obscure it from any side.

The son of another District Supervisor, young Joe Hughes, working as a light trap collector, noticed that when the catches were heavy the holes in the bottom of the dixie cups used to line the killing jars, seemed to fill up with moths and the kills were not then very good. He suggested that if more holes were made higher on the sides of the cups, the fumes could still get in even if the circulation from the bottom holes were cut off.

Sergeant Panguibitan of the 714 Preventive Medicine Company at Camp Stewart, Georgia, has another solution. He puts a circle of cork in the bottom of the dixie cup and sticks insect pins into it like a pin cushion. This makes an insect "tank-trap" and holds the large beetles and moths up in the air, while the less bulky mosquitoes fall between the pins, are killed and are not rubbed into unrecognizability or broken into indistinguishable masses of parts.

The same issue of the *Skeeter* tells us that

Charlie White of North Carolina, who has been a booster of mosquito control in his state for years, and whose assistance was invaluable to the Army in its control efforts during World War II, has an article on the subject in the May, 1955, issue of the N. C. State Health Bulletin, that is both pertinent and informative.

"Largely through the efforts of Charlie White," *Skeeter* says, "A broad program for control of salt marsh mosquitoes has been undertaken in North Carolina and is now under way. Our own experience tells us that this is a large order, but Charlie is just the man to see it through."

CHESTER ROBINSON OF THE ALAMEDA COUNTY M.A.D. REPORTS THAT HAROLD GRAY visited the new office buildings of his former bailiwick and was the honor guest at the dedication ceremonies for the Earl Warren Hall Public Health Building on the University of California campus. It is good to know that Harold has recovered from his unpleasant illness which threatened to start his retirement-vacation off on a poor gait. Chester also reports the happy news that the District moved into their new offices at 3024 E. 7th Street, Oakland 1, California, (telephone Kellogg 3–7321), and adds that "it is hoped that friends of the District will feel at liberty to visit us here at any time."

WHO'S WHO IN THE AMERICAN MOSQUITO CONTROL ASSOCIATION BRINGS US TO CONSIDERATION OF SEVERAL WHOSE NAMES HAVE BEEN IN *Mosquito News* OF LATE:

WILLIAM E. BECKEL, recently and for the past six years at the Defence Research Northern Laboratory, Ft. Churchill, Canada, was born in Kingston, Ontario and graduated from Queen's University, Kingston, Ontario in 1949.

Bill then spent a year with the Division of Entomology of the Canadian Department of Agriculture, working in Forest Entomology and Systematics. From here he went to the Defence Research Board and has done intensive mosquito research in the virtually arctic tundra regions around Ft. Churchill, on Hudson's Bay. He received a Master's Degree from the University of Iowa in 1952 and a Doctor's from Cornell in 1955. He plans to join the Field Crops Insect Unit of the Dept. of Agric., at Chatham, Ontario, this fall, where he will work on ecology and physiology. We hope this won't mean that he is abandoning mosquitoes and us. He lists his hobbies as "gracious living" a desire undoubtedly intensified by the rigors of his arctic living. (Those who have seen the very plush Club at Ft. Churchill will know what we mean.)

RICHARD M. BOHART, whose definitive work in the Pacific during the Second World War has made him an authority familiar to many, was born in 1913 in Palo Alto, California. In spite of this handicap, he graduated from the University of California in Berkeley in 1934, received his MS there in 1935 and went on to earn a PhD in 1938. He was an instructor at the same University and is now an associate professor at the Davis campus. His work, above mentioned, in the Pacific was done under the aegis of the Medical Service of the Navy, which he left with the rank of Lieutenant Commander. His hobbies are insect collecting, a rewarding and not too difficult hobby in California, and painting, another urge which is easy to stimulate and to satisfy in the Golden State.

WILLIAM C. FROHNE, who has sent us several observations on mermythid parasites, is currently at the Arctic Health Research Center of the U.S.P.H.S. in Anchorage, Alaska. He says his early training was really in Limnology but that Dr. Louis Williams proselyted him to mosquito work in Savannah by introducing him to the marvels of anopheline larval ecology. Working in malariology at Salonika, Greece, he developed a colony of *Anopheles superpictus* which was used by laboratories in Athens and Rome and by the Wellcome Laboratory in England. Bill says he is promising himself and threatening his wife with a tour in the tropics next, when their three teen-age boys are in college.

DONALD J. PLETSCH was born in 1912 in Lake City, Minnesota and graduated *cum laude* in 1932 from Hamline University in St. Paul. His MS and PhD degrees followed in 1936 and 1942 from the University of Minnesota and meantime he had commenced his teaching and research career in Montana State College and the Montana Agricultural Experiment Station in Bozeman. On April 1, 1943, he found himself entered into the Army of the United States, and Uncle Sam wasn't fooling. As Commanding Officer and Entomologist of the 218 Malaria Survey Detachment, Don saw duty in Camp Grant, Camp Plauche and then overseas in New Caledonia, Leyte and Hokkaido, Japan. His athletic ability and zest for life stood him in good stead in the years after the war when he went all over Japan preaching insect control for SCAP, MacArthur's Scientific and Technical Division. After a short tour in Washington, D. C., he went to Taiwan (Formosa) to direct the malaria control being done by W.H.O. on that Island. *O-kaerimashita*, Don! *Irrashai!*

ERNESTINE THURMAN was born in 1920 (which is so recent that we're sure she won't mind our telling it) in Atkins, Arkansas and graduated from the College of the Ozarks in 1943. In 1944 she was at Tulane University in New Orleans working in culicidology, from which she went to the Malaria Control in War Areas organization of the USPHS at Jacksonville, Florida. In 1948 she and Deed C. Thurman were married and later that year were assigned to the California Bureau of Vector Control in Berkeley. From there they

went to the National Institutes of Health in Bethesda, Maryland, and in 1951, commissioned now as a Senior Assistant Sanitarian, and with the diplomatic rank of Attaché, she accompanied her husband to Chiengmai, Thailand. Their joint efforts resulted in a highly successful completion of their mission, which was, however, tragically terminated, as AMCA members will recall, by the death of her husband, Lt. Commander Thurman. Ernestine returned to Washington where she heroically carried on the finale of their joint work and has since proceeded earnestly and successfully with her research work for the Division of International Health and the Thai Mission, at the U. S. National Museum. Ernestine is a member of the Commissioned Officers Association of the PHS, the Siam Society, the Entomological Society of America, the Florida and California Mosquito Control Associations, and American Public Health Association, the American Society of Professional Biologists, the American Society of Parasitology, and others. With her young daughter and son, she lives presently in Washington, D. C. and is assigned by N.I.H. at the University of Maryland, nearby.

All the Kind, Generous and Loyal Members of A.M.C.A. who have been sending in items for "News and Notes," are urged not to stop now, but to continue sending them in to the new address of the News and Notes Editor, which will henceforth be: Austin W. Morrill, DD–111, District Public Works Office, Headquarters 12th Naval District, San Bruno, California. (And that's the reason for all those polite remarks we've been making about California.)

OBITUARY

As this issue of *Mosquito News* was going to press, we received news of the death of Bill Komp on December 7.

Born in Yokohama, Japan, he returned to this country and studied at Rutgers University, where he received his B.S. in 1916 and his M.S. in 1917. After being a fellow at Cornell University for a year, he joined the U. S. Public Health Service. Among his assignments with the Public Health Service was his work at the Gorgas Memorial Laboratory in Panama. He was also a traveling representative of the Pan American Sanitary Bureau and a member of the Institute of Inter-American Affairs.

He was a member of a number of professional societies, including the American Association for the Advancement of Science, the American Mosquito Control Association, the Society of Tropical Medicine, the Entomological Society of Washington, the Washington Academy of Medicine, the Entomological Society of America, and the Sociedad Venezolano de Ciencias Naturales.

(The above information was furnished by Austin Morrill who had submitted it as part of one of his "Who's Who" sketches for this number of *Mosquito News*. It comes as a shock to all of us that we are having to write, instead, an obituary.)

REVIEWS AND ABSTRACTS

THE EFFECTS OF ATMOSPHERIC PRESSURE ON THE FLIGHT RESPONSES OF *Aedes aegypti* (L.). W. O. Haufe. Bull. Entom. Res. 45(3):507–526. 19 refs. 1954. Little is known of the effects of variations in pressure on animals, especially invertebrates. The author has studied such effects on the behavior of adult female mosquitoes. The factors included were the "level" of pressure, the direction of a change in pressure (increase or decrease), and the magnitude and rate of such a change.

The equipment and methods used are thoroughly explained. The experiments appear to be well controlled and carefully executed and various statistical methods have been used in the handling of the data. Acclimatization of mosquitoes to different pressures was studied and found to be important from the standpoint of repeatability of results. The mosquitoes appeared to be equally active at the different pressures used, after becoming acclimatized to those pressures.

A "critical" pressure was found for *Aedes aegypti* above which a decreasing pressure was more stimulatory than an increasing one, and below which an increasing pressure was more stimulatory than a decreasing one. There was a suggestion that this pressure may be close to that prevailing at the time of emergence of the adult.

The experiments involving increase and decrease of pressure are rather complex and cannot be briefly summarized; details should be sought in the original. A change in pressure was usually more stimulatory than a constant one, at least above 500 mm. Hg. The author states that "Although the effects of atmospheric pressure on the flight activity of *A. aegypti* are probably of less importance than those of temperature and saturation deficiency, they were found to be sufficiently significant in this investigation to be considered as an important factor." One should, however, be careful in extrapolating from these results to field conditions since the rates and magnitudes of changes in pressure used in this study are, for the most part, much larger than are normally found in nature.—Ralph Barr, University of Kansas, Lawrence, Kansas.

BIOLOGICAL STUDIES ON *Culex tarsalis* (DIPTERA CULICIDAE) IN KANSAS. Lungstrom, L. Trans. Kansas Acad. Sci. 57:86–96. 8 refs. 1954. Studies on the abundance of *Culex tarsalis* Coq. were carried out in Kansas from 1945 to 1949 based on female count. This species was surpassed only by *Aedes vexans* in density and constituted above 21 percent of all mosquitoes caught, as indicated by 31 individual seasonal light trap collections. It was more abundant in the central and western sections of Kansas with the highest population density occurring near the salt marsh area in Stafford and Rice counties. The largest average catches were made during July and August but the peak population in the eastern section of the state occurred later in the season. The amount of precipitation had a great effect upon the abundance of this species. During dry periods the larvae were collected from springs and the adults were scarce.

The eggs measured an average of 0.165 x 0.629 mm. in size. Only 2.6 percent failed to hatch. An average of 155 larvae hatched from each raft in a period of 18–24 hours. They were fed dog chow, chopped grass, cereal food, yeast, algae, and food in creek water. The rate of survival among the larvae reared in a laboratory with artificial food appeared to be low but was highest among those reared on dog chow. The pH (7.80–8.45) of prepared media was higher than the pH of water from ideal field habitats (7.3–7.9). . . . The larvae were collected principally in temporary to semi-permanent pasture depressions, springs, ditches, and creeks. Nearly all collections were made in rural areas with very few from artificial containers. The adults rested during the day in or on farm buildings, under bridges and culverts.

The females began biting with the approach of darkness. Laboratory reared specimens were not so aggressive as field collected ones. Precipitin tests indicate that *C. tarsalis* feeds on the blood of domestic animals and man with the most frequent attacks on chickens and cattle. This mosquito was collected from horses, cattle, and man. Although the precipitin tests indicated little feeding on man, field experience demonstrated that this species attacked one readily. Several specimens collected were engorged with fruit juice resembling mulberry.

The laboratory-reared adults lived up to 9 days during summer but some of the field collected ones lived more than 2 weeks. During the cooler part of the season the females lived at least 40 days. Field collected females oviposited at nearly all hours of day or night in the basement laboratory for 2 weeks at a declining rate. Attempts with several modifications in procedure to rear *C. tarsalis* through the complete life cycle were unsuccessful.—Excerpts from summary by author. Bethany College, Lindberg, Kansas.

THE INVESTIGATION OF A SYLVAN YELLOW FEVER EPIZOOTIC ON THE NORTH COAST OF HONDURAS, 1954. Trapido, H., and Galindo, P. Amer. J. trop. Med. Hyg. 4(4):665–674. 1955. 15 refs. 1. Howling monkeys (*Alouatta*) died of histopathologically proven yellow fever in July and early August, 1954, on the coastal plain near La Masica, Honduras, in an ecological situation unlike that of epizootics experienced during the preceding

five years in Panama and lower Central America. No naturally proven vector mosquitoes could be found on the coastal plain where the monkeys died.

2. Small numbers of *Haemagogus spegazzinii falco,* a proven natural vector in South America, were taken on mountain slopes in the tropical rain forest some 10 to 20 kilometers or more from the place where the monkeys died, but no evidence could be obtained of monkey mortality there. The authors believe the north coast of Honduras to be at or near the northern limit of the range of *H. spegazzinii falco.*

3. *Haemagogus equinus,* which has been shown to be capable of transmitting yellow fever in the laboratory, but from which virus has never been certainly recovered in the field, was the only *Haemagogus* species recovered at the place where the monkeys died near La Masica. This species which is widespread in Middle America has been taken by us in the Atlantic drainage as far north as the southwestern corner of the Mexican state of Tamaulipas which borders Texas on the Gulf Coast.

4. Aside from the predominantly ground-level biting *Psorophora* and *Mansonia,* which are not considered to be involved in the yellow fever transmission, the commonest arboreal mosquito was *Trichoprosopon magnus.* The ability of this mosquito to transmit virus is unknown. Another sabethine mosquito whose status as a vector is also not known, *Sabethes chloropterus,* was present in moderate numbers. This species has been present at other recent yellow fever episodes in Panama and lower Central America.

5. No human cases of yellow fever were recognized in the immediate area of the epizootic during, or in the months following the monkey fatalities.—Summary and conclusions by the authors, Gorgas Memorial Laboratory, Panama, R. de P.

The National Campaign Against Malaria in Iraq: Progress Report, 1946–1952. I. Pringle, G. Bull. Endemic Dis. 1(2):87–117. 2 maps, 18 tables. Jan. 1955. Pub. by The Institute of Endemic Diseases, Ministry of Health, Baghdad, Iraq. The organization of the Institute of Endemic Diseases is described, and the development of the malaria control project in Iraq, 1947–1953, outlined. Information gathered during the surveys is grouped according to regions (subdivided into districts) each of which has special geographical and epidemiological features. These features are related to the flooding characteristics of the Tigris, Dyala, and Euphrates, and are used rather than administrative boundaries.

Region I. Shatt Al-Arab and Hammar Lake Littorale. *Anopheles stephensi* is the most important malaria vector, followed by *A. sacharovi.*

Region II. Alluvial Plain. District 2 A. Euphrates-alluvial. Vector, *A. stephensi.* District 2 B. Tigris-alluvial. Chief malaria vectors apparently are *A. stephensi* and *A. superpictus. A. pulcherrimus* was abundant in certain areas, but obviously low in transmission rate, while *A. sacharovi* was found but not connected with infections present. District 2 C. Dyala-alluvial. Predominant malaria vector, *A. stephensi.* Sometimes there are invasions of *A. sacharovi* and *A. superpictus.*

Region III. Syrian Desert. District 3 A. Euphrates-Syrian Desert. No malaria apparent, no anophelines collected. District 3 B. Tigris-Syrian Desert. Comparatively healthy area, and no anophelines were studied. 3 C. Spring-fed Oases-Syrian Desert. Vectors are *A. stephensi* and *A. fluviatilis.*

Region IV. Steppe-Desert. District 4 A. Tigris-Steppe. District 4 B. Dyala-Steppe. District 4 C. Zab-Steppe. District 4 D. Jezira-Steppe. No data given in this report.

Region V. Submontane. District 5 A. Tigris-Submontane. District 5 B. Zab-Submontane. District 5 C. Dyala-Submontane. No data given in present report.

Region VI. Zagros-Montane. No data given in present report.

The first three Regions are discussed in some detail. In addition to the supporting tables appended, there are six subjects considered under each District: (1) General notes which outline boundaries, ecology, status of malaria and vectors; (2) Administrative notes; (3) Control work undertaken, may be either, or a combination of, drain, fill, ditch, oil, clear, residual spray, or *Gambusia* introduction; (4) Results of control operations which include discussions of spleen indices supported by a short table in the text; (5) Course of malaria in uncontrolled communities is a report of some random observations; and (6) Scale of operations, heads paragraph giving numbers of laborers employed, density of population, etc.

The insecticides used were Gammexane and/or DDT. According to the author: "The dosage aimed at, with each spray, is 1 gm. of technical DDT/sq. meter, when oil formulations are used, and twice this dosage with wettable formulations of DDT. On the few occasions when spraying was carried out with Gammexane, the dosage aimed at was the equivalent of just over 0.1 gm. of gamma isomer BHC/sq. meter."—H. L. T. D.

Effect of Clothing Color on Mosquito Attack on Exposed Skin. Brown, A. W. A. Journ. Econ. Ent. 48(2):130. 1955. This is a one-page report on a project at Goose Bay, Labrador, during the period June 25 to July 6, 1953. The principal species of mosquitoes were *Aedes communis* (Dcg.), *A. punctor* (Kby.), *A. pionips* Dyar, and *A. fitchii* (F. & Y.) These tests were undertaken to determine whether an "unattractive" (a white drill coverall and a green nylon "insect suit") garment would decrease the attacks on hands and face of wearer, or increase it by discouraging mosquitoes from landing on the garment itself. "Attractive" clothing included a black drill coverall

and a serge "air force blue" battledress. The landing rates of these species on backs and faces of the wearers are listed in tabular form. There were 4 tests or counts for each pair of clothing, and each pair was tried on 4 different pairs of wearers. The results suggest "that the expected diminution in the swarm around an unattractively clothed person is partially negated by a greater portion of the swarm proceeding to the face." It was concluded "that lighter-colored clothing does not increase the attack of mosquitoes on the face, although a significant decrease was obtained only with white versus black."—H.L.T.D.

A STUDY OF PREDATORS OF MOSQUITO LARVAE AND PUPAE WITH A RADIO-ACTIVE TRACER. W. F. Baldwin, H. G. James, and H. F. Welch. Can. Ent. 87(8):350–356. 1955.—Larvae and pupae of *Aedes stimulans* (Wlk), and *A. trichurus* (Dyar) were made radio-active with P^{32} and released in natural ponds near Chatterton, Ontario in 1953. The following day animals were collected from the ponds and tested for radio-activity. Predacious diving beetles (Dytiscidae), caddis-worms (*Limnephilus*), and larvae of water scavenger beetles (*Hydrophilus*) were the most important predators. The population density of mosquitoes decreased by approximately 40 percent from April 14 to May 11. During the same period there was a great increase in the number of predators and the percentage of radio-active animals.—W. E. Bickley, University of Maryland, College Park, Md.

CONSIDERAÇÕES GERAIS SOBRE A EPIDEMIOLOGIA DA MALÁRIA NO SUL DO BRASIL. Rachou, R. G., Ferreira, M. O., Lôbo, A. G. S., and Pires, W. M. Rev. Bras. Malariol. e Doenças Trop. 6(2): 177–188.1954. 3 tables, 3 graphs, 2 maps. In the south of Brazil, malaria is transmitted by *A.* (*K.*) *cruzii*, *A.* (*K.*) *bellator*, *A.* (*N.*) *darlingi*, and probably *A.* (*N.*) *albitarsis*. On the coast, the two species of the sub-genus *Kerteszia* are responsible for endemic malaria. *A.* (*N.*) *darlingi* is found in the north of Paraná State, part of which has endemic malaria and part epidemic malaria with long periodicity (4, 5 or 6 years). In the Valley of Uruguai River are little foci of epidemic malaria, probably transmitted by *A.* (*N.*) *albitarsis*. The control of malaria in the region, no matter the different vectors, has been made quite satisfactory by the DDT house spraying.—Authors' summary.

RESULTADOS PRELIMINARES DE UMA PROVA DE CAMPO PARA COMPARAÇÃO DA EFICÁCIA DE 3 INSETICIDAS DE AÇÃO RESIDUAL APLICADOS NO INTERIOR DAS CASAS PARA COMBATE AO *Culex fatigans*. Rachou, R. G., Ferreira, M. O., and Lima, M. M. Rev. Bras. Malariol. e Doenças Trop. 6(2):159–172. 1954. 3 tables, 6 graphs. The authors present the results of the first 6 months of the experiment they are conducting in Florianópolis (mean temperature: 22°–16° C.) to evaluate the efficacy and the residual effect of three insecticides, applied indoors—BHC, DDT, and dieldrin—to control *Culex fatigans*, the vector of bancroftiasis in Brazil. (Applied doses: per sq. meter: mgr. of gamma isomer with BHC—emulsion, 410 mgr. of gamma isomer with BHC-suspension, 2.6 gr. of DDT and 0.95 gr. of dieldrin.) The preliminary results indicate: (1) a very good residual effect of BHC-emulsion and of dieldrin for six months; (2) lower effectivity of BHC-suspension as compared with BHC-emulsion; (3) DDT as the least efficient of the three tested insecticides. The long residual effect of BHC-emulsion is probably due to the low temperature of the region.—Author's summary.

FILARIOSES HUMANAS NO BRASIL. CONHECIMENTO ATUAL DE SUA DISTRIBUICÃO GEOGRÁFICA E TRANSMISSÃO. Rachou, R. G. and Deane, L. M. Rev. Bras. Malariol. e Doencas Trop. 6(3) 377–387. 1954. 22 refs. 4 tables. In Brazil, from the data available at present, autochthonous infections by *Wuchereria bancrofti* are known to occur in Manáus (State of Amazonas), Vigía, Bragança and Cametá (State of Pará), Recife (State of Pernambuco), Macció (State of Alagoas), Salvador (State of Bahia), Florianópolis and Ponta Grossa (State of Santa Catarina) and Pórto Alegre (State of Rio Grande do Sul); *Mansonella ozzardi* is endemic in Manáus, Tefé, Fonte Boa, São Paulo de Olivença, Benjamin Constant, Remate de Males, Maria Açu and Ataláia (State of Amazonas).

W. bancrofti occurs principally along the coast with a spotty distribution; in few localities its incidence is so high as to make it an important public health problem. *M. ozzardi* is found in the interior and so far, has been encountered only in the forested plains of the Amazon Region, sparsely inhabited by a population with a preponderance of the Indian element.

All cases of Bancroftian filariasis studied, both in the North and South of the country, harbored embryos with a definite nocturnal periodicity. The usual vector of *W. bancrofti* in the country is *Culex fatigans*, although other species of mosquitoes can transmit the parasite as secondary vectors.—Authors' summary.

OBSERVAÇÕES PRELIMINARES SÔBRE AS VARIAÇÕES ESTACIONAIS DE ALGUNS FATORES FÍSICOS E QUÍMICOS NAS ÁGUAS DE CRIADOUROS DE *A. darlingi* NO SUL DO BRASIL. De Andrade, R. M., Rachou, R. G., and De Souza, M. A. Rev. Bras. Malariol. e Doenças Trop. 6(3): 415–418. 1954. 1 table. The authors present the temperatures (water and air), pH, total acidity, chlorine content, total calcium and magnesium hardness, calcium and magnesium of breeding places of *Anopheles darlingi* Root, 1926, in Marques dos Reis Village, Jacarèzinho County, State of Paraná, Brazil, during two months, February (Summer) and July (Winter) 1952.—Authors' summary.

Inquérito de Filariose Bancroftiana em Florianópolis, Capital do Estado de Santa Catarina. Rachou, R. G., Ferreira, M. O., and Lima, M. M. Rev. Bras. Malariol. e Doenças Trop. 6(2):189–204. 1954. 4 tables, 4 graphs and 2 maps. The authors carried out an epidemiological survey to ascertain the incidence and transmission of bancroftiasis in Florianópolis, capital of Santa Catarina State. They examined the blood taken at night from 3,663 inhabitants (7.2 percent of the population), obtaining a microfilaria rate of 1.4 percent and an average count of microfilariae of 8.3 (20 cmm. of blood per sample). *Culex fatigans* was found naturally infected (2.5 percent among 1,302 dissected specimens); 0.5 percent from the dissected specimens harbored infective larvae. The authors conclude that the incidence of bancroftiasis is low in Florianópolis, although the so-called zone 1 ought to be considered as a focus of relative importance. —Author's summary.

Relação Entre a Microfilaremia Horária da *"Wuchereria bancrofti"* e a Freqüência. Domiciliária Horária do *"Culex fatigans"* no Norte e no sul do Brasil. Rachou, R. G., Deane, L. M., Damasceno, R. G., and Lima, M. M. Rev. Bras. Malariol. e Doenças Trop. 6(2):205–218. 1954. 3 refs., 5 tables, and 6 graphs. Based on observations made in two cities, Belém and Florianópolis, respectively, in northern and southern Brazil, the authors were able to confirm the exsitence of a correlation between the periodicity of *Wuchereria bancrofti* and the hematophagic activity of *Culex fatigans* inside houses in both cities. The microfilariae have a definite nocturnal periodicity, the peak of which is at 1 a. m. in Belém and at 4 a. m. in Florianópolis.—Authors' summary.

An Account of the Taxonomy and Biology of the Larvae of Culicine Mosquitoes in Iraq. I. Central Iraq. By Fadhil H. Khattat. Bull. Endemic Dis. 1(2):156–183. 1955. (In English) 6 tables, 4 figs., 8 plates, 17 refs. In 1954, a survey was made of the culicine breeding places during the period from August through November; and the information included in this paper is based for the most part on material obtained at this time and considered fairly representative for the autumn and early winter seasons.

The species collected were identified and important taxonomic features sketched by the author, who also compares chactotaxy in 2 tables. He lists *Aedes caspius* Pallas, *Culex pipiens* Linn., *C. pusillus* Macq., *C. theileri* Theo., *C. tritaeniorhynchus* Giles, *Theobaldia longiareolata* Macq., *T. subochrea* Edw., and *Uranotaenia unguiculata* Edw. The *Uranotaenia,* although rare, was recorded for the first time from this area.

It is of interest, although the author does not mention it, that *Theobaldia subochrea* is a species described as autogenous by Marshall and Staley, 1936.—H. L. T. D.

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO CONTROL WORKERS AND MALARIOLOGISTS

HELEN SOLLERS
Plant Pest Control Branch
Agricultural Research Service
United States Department of Agriculture

ADULTICIDES

INSTITUTE OF ENDEMIC DISEASES. 1955. Annual report of the Malaria Section for 1953. Bul. Endemic Diseases (Baghdad) Suppl. 1, pp. 4–17.

PAL, R., SHARMA, M. I. D., KRISHNAMURTHY, B. S., and GABBA, J. L. 1955. Field studies on the comparative effectiveness of D. D. T., B. H. C. and dieldrin residual sprays against anopheline mosquitoes. Indian Jour. Malariol. 9(1):33–49, 13 refs.

RAFI, S. M. 1954. Evaluation of 2nd year of extensive spraying operations in the Punjab during 1953. Pakistan Jour. Health 4(2):66–74.

VAUCEL, M. 1955. La lutte contre le paludisme au moyen des insecticides a action remante apres 10 ans d'application. Rev. Colon. de Med. de Shir. 27(232):22–28, 13 refs.

VISWANATHAN, D. K., BHATIA, S. C., and HALGERI, A. V. 1955. Field trials on the relative efficacy of different dosages and formulations of D. D. T., B. H. C., combination of D. D. T. and B. H. C. and dieldrin in malaria control in certain rural areas in Bombay State. Indian Jour. Malariol. 9(1):51–70, 11 refs.

LARVICIDES

COLLIGNON, E., and JUILLAN, M. 1955. Les indices endemiques palustres dans le voisinage de la Station Experimentale du Marais des Ouled Mendil en 1954. Inst. Pasteur d'Algerie Arch. 33(1):45–47.

GAHAN, J. B., and MULHERN, T. D. 1955. Field studies with water-soluble insecticides for the control of mosquito larvae in California pastures. Mosquito News 15(3):139–143, 2 refs.

MATHIS, W., ELMORE, C., and SCHOOF, H. F. 1955. Further studies on the chemical control of rice field mosquitoes in Mississippi. Mosquito News 15(3):148–153, 4 refs.

TAMURA, T., and MATSUBARA, H. 1955. On the synergistic action of crystalline pyrethroresine with pyrethroids. 1. Botyu-Kagaku 20(1):4–12. English Summary. [Non-toxic to *Culex pipiens pallens*].

WEBBE, G. 1955. The susceptibility of fourth-stage larvae of *Anopheles gambiae* to oil solutions of DDT and dieldrin under semi-natural conditions. East African Med. Jour. 32(2):41–45.

VARIOUS TYPES OF CONTROL

ANONYMOUS. 1955. Nouvelle orientation de la lutte antipaludique. Sem. Med. Profes. et Med.-Soc. (Suppl. a Sem. des Hopitaux) Paris 31(4):131.

BUEZAS ARIAS, U. 1954. Influencia del paludismo en la patalogia rural; nuestra experiencia de veinticinco años al frente de un servico antipaludiso. Rev. de Sanid. e Hig. Pub. 28(11/12):801–830.

CHOW, C. Y., THEVASAGAYAM, E. S., and WAMBEEK, E. G. 1955. Control of *Salvinia*—a host plant of *Mansonia* mosquitoes. World Health Organ. Bul. 12(3):365–369.

DEHNÉ, E. J. 1955. Fifty years of malaria control in the Panama area. Amer. Jour. Trop. Med. and Hyg. 4(5):800–811, many refs.

EGAN, J. P. 1955. Correlating the state game program with mosquito control work. Utah Fish and Game Bul. 11(6):1–2.

EVLAKHOVA, V. F., GRITSAI, M. K., LAVRENKO, E. M., and BERKOVICH, B. I. 1954. Effectiveness of DDT and hexachlorane in control of mosquito fever in Izmail region. Med. Parazit. i Parazit. (Moskva) 4:334–338. In Russian.

FEDERATION OF MALAYA. Malaria Advisory Board. 1954. Annual report for the year 1953. Kuala Lumpur. 16 pp.

FLOCH, H. 1954. Evolution de la lutte antipaludique en Guyane Française de 1950 à 1954. Inst. Pasteur Guyane Fr. Arch. 15(345):1–8.

GABALDON, A. 1955. Ensenanzas para la accion sanitaria en la America Latina derivadas de la lucha natimalarica en Venezuela. Bol. Ofic. Sanit. Panamer. 38(3):259–265, 6 refs.

LAMBRECHT, F. L. 1954. Notes sur l'anophelisme dans la vallée de la Ruzizi (Kivu-Congo Belge) et des essais de DDT-isation. Soc. Belge Trop. Ann. 34(6):931–961.

LE RENARD, —. 1954. Les étapes de la lutte antipaludique dans l'armée au Maroc. Maroc. Med. 33(352):873–874.

MERLE, F., and MAILLOT, L. 1955. Campagnes de désinectisation contre le paludisme a Brazzaville. Soc. de Path. Exot. Bul. 48(2):242–269, 12 refs.

NAGASAWA, S. 1955. Comparison of the toxicity of aldrin, dieldrin and p, p'-DDT to pupae of the common house mosquito, *Culex pipiens* var. *pallens Coquillett*. Studies on the biological assay of insecticides. XXVIII. Botyu-Kagaku 20(1):12–15, 3 refs. English Summary.

PAL, R., and SHARMA, M. I. D. 1954. Control of culicine mosquitoes with synthetic insecticides. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 2(3):117–222, many refs.

PRINGLE, G. 1955. The national campaign against malaria in Iraq. Bul. Endemic Diseases (Baghdad) 1(2):87–117.

PROKOPENKO, L. I. 1955. Organization of anti-malaria protection in Siberia timberlands. Med. Parazit i Parazit. (Moskva) 24(1):34–40. In Russian.

RONNEFELDT, F. 1955. Das DDT in der malariabekämpfung. Ztschr. f. Tropenmed. Parasitol. 6(2):165–175, many refs.

SACRAMENTO COUNTY-YOLO COUNTY MOSQUITO ABATEMENT DISTRICT. 1955. Seventh annual report for the calendar year January 1, 1954-December 31, 1954. Sacramento. 23 pp.

SOKOLOV, N. P. 1955. Biologicheskii metod bor'by maliaiinym komarom. Fel'dsher I Akusherka (Moskva) No. 2:31–34.

INSECT RESISTANCE

GARRETT-JONES, C., and GRAMICCIA, C. 1955. Pruebas del desarrollo de resistencia al DDT del *Anopheles sacharovi*, en el Levante. Bol. Ofic. Sanit. Panamer. 38(3):274–288, 8 refs.

REID, J. A. 1955. Resistance to insecticides in the larvae of *Culex fatigans* in Malaya. World Health Organ. Bul. 12(5):705–710.

INSECTICIDES AND CHEMICALS

KATUDA, Y., TIKAMOTO, T., and NAKASIMA, K. 1955. Studies on the degradation of pyrethrins. I., II. Botyu-Kagaku 20(1):15–26, refs. English Summary.

SHARMA, M. I. D. 1954. Factors influencing the toxicity of residual insecticides against mosquitoes. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 2(3):110–116, 36 refs.

SRIVASTAVA, R. S., CHAKRABARTI, A. K., and SINGH, N. N. 1955. Study of chemical and photodynamic deterioration of dichloro diphenyltrichloroethane (D.D.T.) when applied on solid surfaces. Indian Jour. Malariol. 9(1):27–32, 7 refs.

TOXICOLOGY

HAYES, W. J., JR. 1955. El estado actual de nuestros conocimientos sobre la intoxicacion por DDT. Bol. Ofic. Sanit. Panamer. 38(4):399–406, 58 refs.

EQUIPMENT

GAHAN, J. B., LABRECQUE, G. C., and BOWEN, C. V. 1955. An applicator for adding chemicals to flowing water at uniform rates. *Mosquito News* 15(3):143–147, 3 refs.

HALL, L. B. 1955. Suggested techniques, equipment, and standards for the testing of hand insecticide-spraying equipment World Health Organ. Bul. 12(3):371–400.

KNIPE, F. W. 1955. Nozzles of insecticide sprayers. Comments from point of view of malaria control. World Health Organ. Bul. 12(3):401–409.

KRUSE, C. W., and LESACA, R. M. 1954. Automatic siphon for the control of *Anopheles minimus* var. *flavirostris* in the Philippines. Amer. Jour. Hyg. 61(3):349–361, 17 refs.

BIOLOGY AND ECOLOGY

BURGESS, R. W. 1955. Experiments in hybridizing *Anopheles freeborni* Aitken and *Anopheles punctipennis* (Say). Ent. Soc. Amer. Ann. 48(4):229–231, 6 refs.

CALLOT, J. 1955. Étude sur les hybrides des biotypes de *Culex pipiens* Linné. Ann. de Parasitol. Humain. et Compar. 30(4):363–373, 11 refs.

DETINOVA, T. S. 1955. Fertility of *Anopheles maculipennis*. Med. Parazit. i Parazit. (Moskva) 24(1):6–11. In Russian.

EDMUNDS, L. R. 1955. Notes on the biology and seasonal abundance of the larval stages of *Culex tarsalis* Coquillett in irrigated areas of Scotts Bluff County, Nebraska (Diptera:Culicidae). *Mosquito News* 15(3):157–160, 6 refs.

GALINDO, P., CARPENTER, S. J., and TRAPIDO, H. 1955. A contribution to the ecology and biology of tree hole breeding mosquitoes of Panama. Ent. Soc. Amer. Ann. 48(3):158–164, 8 refs.

HALCROW, J. G. 1955. Notes on a laboratory colony of *Aedes (Stegomyia) albopictus* (Skuse) and its distribution in Mauritius. Roy. Ent. Soc. London Proc. Ser. A., General Ent. 30(1/3): 40–42, 2 refs.

KOMP, W. H. W. 1955. The breeding of *Haemagogus argyromeris* D. and L. in saline water (Diptera:Culicidae). *Mosquito News* 15 (3):179–180, 5 refs.

———. 1955. The oviposition of *Haemagogus equinus* in nature (Diptera:Culicidae). *Mosquito News* 15(3):163–164.

LAVEN, H. 1955. Strahleninduzierte mutationen bei *Culex pipiens* L. Ztschr. f. Natur. 10(6):320–322, 2 refs.

VERMEIL, C. 1955. Contribution à l'étude d'un biotype Tunisien du moustique commun, *Culex pipiens* L. Inst. Pasteur Tunis Arch. 32(1):137–145, 6 refs.

WALLIS, R. C. 1955. A study of the oviposition activity of three species of *Anopheles* in the laboratory. Amer. Jour. Trop. and Hyg. 4(3):557–563, refs.

BEHAVIOR

ARIARATNAM, V. 1955. A note on the daytime resting habits of *A. culicifacies* in Ceylon. Indian Jour. Malariol. 9(1):17–26, 13 refs.

FROHNE, W. C. 1955. A note on swarms of so-called "woods" mosquitoes in McKinley Park, Alaska. *Mosquito News* 15(3):173–175, 7 refs.

MORPHOLOGY AND PHYSIOLOGY

JONES, J. C. 1955. Thoracic vesicles in *Anopheles* larvae. *Mosquito News* 15(3):168–170, 2 refs.

LEFTWICH, A. W. 1954. Vision and blindness in mosquito larvae as indicated by the submerging reflex. Roy. Ent. Soc. London Proc. Ser. A., General. Ent. 29(10/12):156–162, 6 refs.

DISTRIBUTION

ADAM, J. P. 1955. Quelques *Anopheles* nouveaux pour la faune Camerounaise. Ann. de Parasitol. Humain. et Compar. 30(4):389–394, 22 refs.

BEJARANO, J. F., and DURET, J. P. 1954. Hallazago de *Haemagogus uriartei* en la ciudad de San Luis. Rev. Sanid. Mil. Argent. 53(3): 353–354.

BERNER, L. 1955. Mosquitoes of the Shire River, Nyasaland. Ent. Soc. Amer. Ann. 48(4): 214–218, 6 refs.

BRITZ, L. 1955. Über die steckmücken-fauna (Diptera:Culicidae) des Stadtkreises Leipzig. Ztschr. f. Angew. Zool. 6(1):61–79, 73 refs.

CEFALU, M., and TERMINELLO, L. 1954. L'*Anopheles algeriensis* Theobald in Sicilia. Riv. di Parassitol. 15(4):323–330, 17 refs.

DURET, J. P. 1954. Datos sobre culicidos de la region Cuyana (Diptera:Culicidae). Rev. Sanid. Mil. Argent. 53(3):412–413.

GUELMINO, D., KOSTIĆ, D., and JEVTIĆ, M. 1954. A contribution to the study of *Anopheles* in Serbia. Acad. Serbe Sci. Bul. Classe Sci. Med. 11(2):37–38.

HEDEEN, R. A. 1955. The discovery of a member of the *Anopheles maculipennis* complex breeding in treeholes in France. *Mosquito News* 15(3):161–162, 3 refs.

KOMP, W. H. W. 1955. The occurrence of *Haemagogus boshelli* in Panama. Ent. Soc. Wash. Proc. 57(4):181–182, 5 refs.

LEVI-CASTILLO, R. 1954. The *Haemagogus* of South America. Rev. Ecuatoriana 2(1/2):269–302, 41 refs.

——— 1955. Notas sobre la fauna culicidiana de las Provincias de Azuay y Cañar en la región Austral del Ecuador (1) (Diptera:Culicidae). Rev. Ecuatoriana Ent. Parasitol. 2(1/2):39–49.

MATTINGLY, P. F. 1955. Mosquitoes (Diptera: Culicidae) from the Tropical Institute at Hamburg. Roy. Ent. Soc. London Proc. Ser. B. Taxonomy 24(1/2):27–33, 21 refs.

MESS, A. A. 1955. Mosquitoes in the Stavropol'sk region. Med. Parazit. i Parazit. (Moskva) 24(1):81. In Russian.

SENEVET, G., ANDARELLI, L., BUFFART, G., and DUZER, A. 1955. Quelle est la limite septentrionale de *Culex deserticola* Kirk. en Afrique du Nord? Inst. Pasteur d'Algerie Arch. 33(1): 51–53, 4 refs.

———. 1955. Présence d'*Anopheles multicolor Camb.* près du littoral Algérois. Inst. Pasteur d'Algérie Arch. 33(1):48–50, 7 refs.

THOMPSON, G. A. 1955. An invasion of the Gulf Coast by salt-marsh mosquitoes. *Mosquito News* 15(3):164–165.

TRPIS, M. 1954. Mosquitoes (Diptera:Culicidae) in the Bratislava region. Biológia (Bratislava) 9(4):412–424. In Czechoslovakian).

TAXONOMY

BARR, A. R. 1955. The resurrection of *Aedes melanimon* Dyar. *Mosquito News* 15(3):170–172, 8 refs.

DESINOVA, Z. M. 1955. New strain of *Aedes (Ochlerotatus)*. Med. Parazit. i Parazit. (Moskva) 24(1):58–61.

GASHEN, H. 1954. La valeur du rapport $\frac{T}{P-5}$ pour l'identification du *Culex pipiens autogenicus*. Soc. Ent. Suisse Bul. 27(2):173–175, 4 refs.

KHATTAT, F. H. 1955. An account of the taxonomy and biology of the larvae of culicine mosquitoes in Iraq. Bul. Endemic Diseases (Baghdad) 1(2):156–183, 16 refs.

LEVI-CASTILLO, R. 1954. Cuatro especies nuevas de Sabethini del Ecuador. Rev. Ecuatoriana Ent. Parasitol. 2(1/2):247–255, 6 refs.

——— 1954. *Culex (Phalangomyia) azuayus* n. sp. un nuevo mosquito de altura de Ecuador. Rev. Ecuatoriana Ent. Parasitol. 2(1/2):263–267, 3 refs.

——— 1954. Notes on Ecuadorian mosquitoes—*Haemagogus equinus* in Ecuador and further taxonomic notes on *Uranotaenia aequatoriana*, Levi-Castillo 1953. Rev. Ecuatoriana Ent. Parasitol. 2(1/2):83–86.

MATTINGLY, P. F. 1955. Le sous-genre *Neoculex* (Diptera:Culicidae) dans la sous-region Mediterraneenne. 1. Espece, sous-es-pece et synonymie nouvelles. Ann. de Parasitol Humain. et Compar. 30(4):374–388, 13 refs.

VERMEIL, C. 1955. Nouvelle contribution à l'étude du complexe *Culex pipiens* en Tunisie. Inst. Pasteur Tunis Arch. 32(1):133–135, 5 refs.

TECHNIQUE

BARLOW, F. 1955. A method for removing insecticide residues of wettable powders from sprayed surfaces. World Health Organ. Bul. 12(3):359–364.

BURTON, G. J. 1955. A revised procedure for making rapid permanent mounts of mosquito larvae. *Mosquito News* 15(3):147, 2 refs.

DAVIDSON, G. 1955. Measurement of ampulla of the oviduct as a means of determining the natural daily mortality of *Anopheles gambiae*. Ann. Trop. Med. and Parasitol. 49(1):24–36.

KNIERIM, J. A., LEA, A. O., DIMOND, J. B., and DELONG, D. M. 1955. Feeding adult mos-

quitoes on preserved blood to maintain egg production. *Mosquito News* 15(3):176–179, 10 refs.

MACDONALD, G. 1955. The measurement of malaria transmission. Roy. Soc. Med. (London) Proc. 48(4):291–295.

SHEMANCHUK, J. A., FREDEEN, F. J. H., and KRISTJANSON, A. M. 1955. Studies on flight range and dispersal habits of *Aedes flavescens* (Müller) (Diptera:Culicidae) tagged with radiophosphorus. Canad. Ent. 87(9):376–379, 3 refs.

WILSON, D. B., and MSANGI, A. S. 1955. An estimate of the reliability of dipping for mosquito larvae. East African Med. Jour. 32(2): 37–39.

DISEASES

ANONYMOUS. 1954. Myxomatosis in man. Amer. Med. Assoc. Jour. 156(13):1270.

———. 1955. Myxomatosis and the rabbit problem in Australia. World Crops 7(1):118–120.

DOLMATOVA, A. V. 1955. Method of permanent eradication of foci of mosquito fever in Crimea. Med. Parazit. i Parazit. (Moskva) 24(1): 48–52. In Russian.

FAUST, E. C. 1955. History of human parasitic infections. U. S. Pub. Health Serv. Rpts. 70(10):958–965, refs.

HOOGSTRAAL, H. 1955. Research on arthropods and arthropod-borne diseases at U. S. Naval Research Unit No. 3, Cairo, Egypt. U. S. Nav. Med. Res. Unit. No. 3 Information Bul. Feb. 18, 22 pp., refs.

JACOTOT, H., VALLÉE, A., and VIRAT, B. 1955. Étude d'une souche atténuée de virus du myxome (uriarra III d'Australie). Inst. Pasteur Ann. 89(1):8–15.

KON', I. S. 1954. Characteristics of curves of morbidity of mosquito fever. Med. Parazit. i Parazit. (Moskva) 4:341–344. In Russian.

MANSON-BAHR, P. 1954. Manson's tropical diseases. A manual of diseases of warm climates. Baltimore, 1,144 pp.

TAYLOR, R. M., and COWORKERS. 1955. Sindbis virus: a newly recognized arthropod-transmitted virus. Amer. Jour. Trop. Med. and Hyg. 4(5): 844–862, 10 refs.

THOMPSON, H. V. 1954. Myxomatosis of rabbits. Agriculture (London) 60(11):503–508.

THOMPSON, H. V. 1954. Myxomatosis: recent developments. Agriculture (London) 61(7):317–321.

WORK, T. H., HURLBUT, H. S., and TAYLOR, R. M. 1955. Indigenous wild birds of the Nile Delta as potential West Nile virus circulating reservoirs. Amer. Jour. Trop. Med. and Hyg. 4(5):872–888, many refs.

ENCEPHALITIS

FINLEY, K. H., and COWORKERS. 1955. Western equine and St. Louis encephalitis; preliminary report of a clinical follow-up study in California. Neurology 5(4):233–235.

HOLDEN, P. 1955. Recovery of western equine encephalomyelitis virus from naturally infected English sparrows of New Jersey, 1953. Soc. Exptl. Biol. Proc. 88(3):490–492.

———. 1955. Transmission of eastern equine encephalomyelitis in ring-necked pheasants. Soc. Exptl. Biol. and Med. Proc. 88(4):607–610.

PATTYN, S. R., and WYLER, R. 1955. Méningo-encéphalite à virus en Autriche. IV. La virémie dans l'infection expérimentale; essais de transmission par les moustiques. World Health Organ. Bul. 12(4):581–589.

FILARIASIS

ALHADEFF, R. 1955. Clinical aspects of filariasis. Jour. Trop. Med. and Hyg. 58(8): 173–179, 9 refs.

BURCH, T. A., and GREENVILLE, H. J. 1955. Filariasis in Liberia. Amer. Jour. Trop. Med. and Hyg. 4(1):47–51.

JACKOWSKI, L. A., JR., and OTTO, G. F. 1955. Filariasis in American Samoa. IV. Prevalence of microfilaremia in the human population. Amer. Jour. Hyg. 61(3):334–348, 16 refs.

JORDAN, P. 1955. Filariasis in the central province of Tanganyika. East African Med. Jour. 32(1):15–16.

KRISHNASWAMI, A. K. 1955. Filariasis in Mangalore (South India). Indian Jour. Malariol. 9(1):1–16, 4 refs.

MALARIA

ANANTHASWAMY, B. 1954. The cost of malaria and its control. A paradox. Indian Med. Gaz. 89(6):383–384.

ANDREWS, J. M., GRANT, J. S., and FRITZ, R. F. 1955. Effectos de la suspension del rociamiento residual y del paludismo importado en el control de la malaria en Estados Unidos. Bol. Ofic. Sanit. Panamer. 38(3):266–273, 15 refs.

BECK, J. W. 1955. Malaria. Amer. Jour. Tech. 21(2):87–88.

BEUTLER, E., DERN, R. J., and FLANAGAN, C. L. 1955. Effect of sickle-cell trait on resistance to malaria. Brit. Med. Jour. 4923:1189–1191, 6 refs.

BRITISH MEDICAL JOURNAL. 1955. Sickling and malaria. Brit. Med. Jour. 4934:310–311.

BUIANOVA, O. F. 1955. Results of the survey of prognosis of malaria in the V. I. Lenin Volga-Don navigable canal during its first years of existence. Med. Parazit. i Parazit. (Moskva) 24(1):25–26. In Russian.

COLBURNE, M. F., and WRIGHT, F. N. 1955. Malaria in the Gold Coast. West African Med. Jour. 4(1):3–17.

D'ALESSANDRO, G., and COWORKERS. 1954. Indagini su malaria e anofelismo in Sicilia nell

anno 1953. Ann. d. San. Pub. 15(6):1147–1167, 18 refs. English Summary.

DELIYANNIS, G. A., and TAVLARAKIS, N. 1955. Compatibility of sickling with malaria. Brit. Med. Jour. 4934:301–302, 11 refs.

EJERCITO, A. 1955. Philippine national malaria programme. Philippine Med. Assoc. Jour. 31(1):1–17.

FLOCH, H. 1954. Discussion sur la régression du paludisme. Inst. Pasteur Guyane Fr. Arch. 15(348):1–6.

———. 1954. Exophilie des *Anopheles* et transmission résiduale du paludisme. Inst. Pasteur Guyane Fr. Arch. 15(346):1–7.

HENTSCH, H. F. G. 1955. Beobachtungen über die häufighkeit kongenitaler malaria auf Timor. Ztschr. f. Tropenmed. u. Parasitol. 6(2):184–187, 3 refs.

HUFF, C. G. 1954. A review of the literature on susceptibility of mosquitoes to avian malaria, with some unpublished data on the subject. Nav. Med. Res. Inst. (Bethesda, Md.) Res. Rpt. Proj. NM 005 048. 01. 10 12:619–644.

INSTITUTE OF ENDEMIC DISEASES. 1955. Results of the malaria control campaign to 1953. Bul. Endemic Diseases (Baghdad) Suppl. 1, pp. 18–19.

IVANOVA, L. V., and NEMIROVSKAIA, A. I. 1955. Attempted typing of malarial foci in a mountain region in Azerbaidzhan. Med. Parazit. i Parazit. (Moskva) 24(1):30–34. In Russian.

LOZANO MORALES, A. 1955. Comentarios sobre una visita a los servicios antipalúdicos de Italia y Grecia. Rev. de Sanid. e Hig. Pub. 29(1/2):102–108.

MANSON-BAHR, P. H. (Editor) 1954. Manson's tropical diseases. A manual of the diseases of warm climates. 14th ed., Baltimore, 1,144 pp.

OLIFAN, V. I. 1955. Fish farms and their role in malaria. Med. Parazit. i Parazit. (Moskva) 24(1):20–24. In Russian.

PAMPANA, E. J., and RUSSELL, P. F. 1955. Malaria: a world problem. World Health Organ. Chron. 9(2/3):31–100.

RAPER, A. B. 1955. Malaria and the sickling trait. Brit. Med. Jour. 4923:1186–1189.

RUSSELL, P. F. 1955. Man's mastery of malaria. London, 308 pp.

SANTA-URSULA PUERTAS, M. 1954. Factores etiologicos del paludismo. Med. y Cirug. Guerra (Madrid) 16(12):729–741.

SERGENT, ED. 1954. La premunition antipaludique et les acces de premuis. Riv. di Parassitol. 15(4):651–654.

STARKEY, D. H. 1955. Studies of Korean vivax malaria. Canad. Serv. Med. Jour. 11(2): 80–82.

TROFIMOV, G. K., and LYSENKO, V. F. 1955. Mountain malaria in southern Azerbaidzhan. Med. Parazit. i Parazit. (Moskva) 24(1):26–30. In Russian.

VAN POLL, F. M. 1955. Een geval van autochthone malaria in Noord-Brabant. Nederland. Tijdschr. v. Geneesk. 99(1):28.

Malaria—Clinical Aspects

BIGNAMI, A. 1954. Studi sull 'anatomia patalogica della infezione malaria cronica. Riv. di Malariol. 33(4/6):185–245.

BLACK, R. H. 1955. Deaths from malaria on the Australian mainland. Med. Jour. Austral. 42(11):387–388.

HARNAGEL, E. E., and RHUDY, F. V. 1955. Falciparum malaria; report of a fatal case and autopsy findings. Moore-White Med. Found. Bul. 6(1):9–13.

MAILIAN, L. M. 1955. Treatment of malarial splenomegaly. Terapevticheskii Ark. (Moskva) 27(1):77–81.

MYERS, F. M. 1955. Een patiente met maagpoliep, transfusie-malaria en peritonitis. Nederland. Tijdschr. v. Geneesk 99(1):21–27.

SANTA-URSULA PUERTAS, M. 1955. Clínica del paludismo. Med. y Cirug. Guerra 17(1): 27–37.

SCHULZE-BAHR, H. 1954. Können wir heute nach malaria shwerhörigkeit erwarten? HNO; Beih. z. Ztschr. f. Hals-, Nasen;, und Ohrenheilkunde (Berlin) 4(10):308–310.

SISON, A. B., CAMPOS, P. C., REYES, B., and ZARATE, E. 1954. The abdominal manifestations of malaria. Acta. Med. Philippina 10(3): 449–464.

VACHON, A., and COWORKERS. 1955. Séatose hépatique d'origine paludéene; régression sous l'influence du traitement du paludisme. Arch. Mal. App. Digest. (Paris) 44(2):241–245.

Malaria—Epidemiology

SANTA-URSULA PUERTAS, M. 1955. Epidemiología y profilaxis del paludismo. Med. y Cirug. Guerra (Madrid) 17(2):93–107.

SIMONOVITCH, E. N. 1954. Epidemiology and detection of mosquito fever in new regions. Med. Parazit. i Parazit. (Moskva) 4:341–344.

Malaria—Eradication Projects

ORGANIZACION SANITARIA PANAMERICANA, DOCUMENTO CSP 14/16. 1955. Erradicacion de la malaria en las Americas. Bol. Ofic. Sanit. Panamer. 38(3):237–239.

SOPER, F. L. 1955. La erradicacion de la malaria en el Hemisferio Occidental. Bol. Ofic. Sanit. Panamer. 38(3):231–236.

Malaria—Plasmodia

BEUTLER, E., DERN, R. J., FLANAGAN, C. L., and ALVING, A. S. 1955. The hemolytic effect of primaquine. VII. Biochemical studies of drug-sensitive erythrocytes. Jour. Lab. and Clin. Med. 45(2):286–295, 38 refs.

BRAY, R. S. 1954. The mosquito transmission of *Plasmodium berghei*. Indian Jour. Malariol. 8(4):263–274, many refs.

CORRADETTI, A., VEROLINI, F., and TOSCHI, G. 1954. Pathological and immunological host- parasite relationships between albino rat and *Plasmodium berghei.* Indian Jour. Malariol. 8(4): 391–394, 3 refs.

DEMELLO, J. P. 1955. The influence of atmospheric changes in the relationship of the malaria parasites and the human host. East African Med. Jour. 32(4):137–140.

DESMET, R., and FRANKIE, G. 1954. Quelques observations sur l'immunité vis-a-vis du *Plasmodium berghei.* Soc. Belge Med. Trop. Ann. 34(6):881–891.

———. 1954. Some observations about immunity to *Plasmodium berghei.* Indian Jour. Malariol. 8(4):375–390, 4 refs.

FABIANI, G. 1954. Immunology of *Plasmodium berghei.* Indian Jour. Malariol. 8(4):347–362, many refs.

GALLIARD, H., and LAPIERRE, J. 1954. Investigations on immunity to *Plasmodium berghei* infection in mice. Indian Jour. Malariol. 8(4): 363–368, 18 refs.

GREENBERG, J., and COATNEY, G. R. 1954. Some host-parasite relationships in *Plasmodium berghei* infections. Indian Jour. Malariol. 8(4): 313–325, many refs.

LEFROU, G., and MARTIGNOLES, J. 1955. Contribution a l'étude de *Plasmodium kochi. Plasmodium* des singes Africains. Soc. de Path. Exot. Bul. 48(2):227–234, 2 refs.

QUEVAUVILLER, A., and LOUW, J. W. 1955. Recherches sur le paludisme de la souris de laboratoire a *Plasmodium berghei* (Vincke et Lips). I. Sur quelques facteurs susceptibles d'influencer la sévérité de l'infection. Ann. Pharm. Franc. 13(1):20–35.

———, and CHABRIER, P. 1955. Recherches sur le paludisme de la souris de laboratoire à *Plasmodium berghei* (Vincke et Lips). II. Essais chimiotherapeutiques. Ann. Pharm. Franc. 13 (2):111–122.

RAFFAELE, G. 1954. On some problems arising from the observation of the infection with *Plasmodium berghei* in mice and rats. Indian Jour. Malariol. 8(4):291–299, 24 refs.

RAMAKRISHNAN, S. P. 1954. Malaria and nutrition with special reference to *Plasmodium berghei* infections in rats. Indian Jour. Malariol. 8(4):327–332, many refs.

RAY, N. K., and BOSE, A. N. 1954. Preliminary observations on estrogen in *P. berghei* infection. Indian Jour. Malariol. 8(4):309–311.

RODHAIN, J. 1954. The absence of cross immunity between *Plasmodium berghei* (Vincke and Lips) and *Plasmodium vinckei* (Rodhain). Indian Jour. Malariol. 8(4):369–373, 6 refs.

SCHNEIDER, J. 1954. *Plasmodium berghei* and chemotherapy. Indian Jour. Malariol. 8(4): 275–279, 8 refs.

SERGENT, ED. 1954. Experimental study on the immunology of malaria due to *Plasmodium berghei.* Indian Jour. Malariol. 8(4):333–345, many refs.

SINGH, JASIVANT. 1954. A written symposium on *Plasmodium berghei* Vincke and Lips, 1948. Introduction. Indian Jour. Malariol. 8(4):237–240, 5 refs.

———, RAMAKRISHNAN, S. P., PRAKASH, S., and BHATNAGAR, V. N. 1954. Studies on *Plasmodium berghei* Vincke and Lips, 1948. XX. A physiological change observed in sulphadiazine resistant strain. Indian Jour. Malariol. 8(4): 301–307, 10 refs.

VAN DEN BERGHE, L. 1954. The history of the discovery of *Plasmodium berghei.* Indian Jour. Malariol. 8(4):241–243.

VASINA, S. G., and ZASUKHIN, D. N. 1955. Development of tissue forms of *Plasmodium gallinaceum* in chick embryo. Med. Parazit. i Parazit. 24(1):40–46. In Russian.

VINCKE, I. H. 1954. Experimental transmission of *Plasmodium berghei.* Indian Jour. Malariol. 8(4):257–262, 16 refs.

———. 1954. Natural history of *Plasmodium berghei.* Indian Jour. Malariol. 8(4):245–256, 21 refs.

Malaria—Therapeutics and Antimalarials

BASS, B. H., and MACFARLANE, R. G. 1955. Treatment of vivax malaria by pyrimethamine (daraprim) and quinine. Jour. Roy. Army Med. Corps 10(12):153–154.

BEUTLER, E., DERN, R. J., and ALVING, A. S. 1955. The hemolytic effect of primaquine. VI. An *in vitro* test for sensitivity of erythrocytes to primaquine. Jour. Lab. and Clin. Med. 45(1): 40–50, 12 refs.

DERN, R. J., BEUTLER, E., and ALVING, A. S. 1955. The hemolytic effect of primaquine. V. Primaquine sensitivity. Jour. Lab. and Clin. Med. 45(1):30–39, 12 refs.

DERN, R. J., and COWORKERS. 1955. Toxicity studies of pyrimethamine (daraprim). Amer. Jour. Trop. Med. and Hyg. 4(2):217–220, 4 refs.

DEMELLO, J. P., and DEMELLO, R. N. 1955. Camoquin as a malaria suppressant. Jour. Trop. Med. and Hyg. 58(7):162–163, 1 ref.

GUNTHER, C. E. M. 1954. A fatal overdose of "daraprim." Med. Jour. Austral. 2(25):970.

HOEKENGA, M. T. 1955. The treatment of malaria with hydroxychloroquine. Amer. Jour. Trop. Med. and Hyg. 4(2):221–223, 8 refs.

SCHMIDT, L. H., and COATNEY, G. R. 1955. Review of investigations in chemotherapy (U. S. A.) 1946–1954. Amer. Jour. Trop. Med. and Hyg. 4(2):208–216.

WILSON, T., and EDESON, J. F. B. 1954. Studies on the chemotherapy of malaria. III. The treatment of acute malaria with chloroquine. Med. Jour. Malaya 9(2):115–131, 20 refs.

Malaria—Vectors

KRISHNAN, K. S. 1954. Malaria vectors of India. IV. *A. stephensi* Liston, 1901. Natl. Soc.

India for Malaria and other Mosquito-Borne Dis. Bul. 2(3):98–109, many refs.

SMITH, A. 1955. The distribution and host choice of resting *A. gambiae* and *A. funestus* Giles in cone huts on Ukara Island, Tanganyika. East African Med. Jour. 32(1):7–13.

YELLOW FEVER

ANONYMOUS. 1955. La fievre jaune en Afrique. Sem. Med. Profes. et Med.-Soc. (Suppl. a Sem. des Hopitaux) Paris 31(7):238–239.

ANDERSON, C. R., and DOWNS, W. G. 1955. The isolation of yellow fever virus from the livers of naturally infected red howler monkeys. Amer. Jour. Trop. Med. and Hyg. 4(4):662–664, 2 refs.

BOLETIN DE LA OFICINA SANITARIA PANAMERICANA. 1955. Conferencia de fiebre amarilla. Bol. Ofic. Sanit. Panamer. 34(1):1–82.

BRADLEY, G. H., and ATCHLEY, F. O. 1955. The *"Aedes aegypti"* situation in the United States. Bol. Ofic. Sanit. Panamer. 38(3):289–292.

CÁCERES VIJIL, M. 1954. Charla sobre fiebre amarilla. Rev. Med. Hondur. 22(169):670–673.

CARPENTER, S. J. 1955. A survey of forest mosquitoes in relation to sylvan yellow fever in the Panama Isthmian area. Amer. Jour. Trop. Med. and Hyg. 4(3):525–542, refs.

DINGER, J. E. 1955. Immunity relations between dengue and yellow fever. Doc. Med. Geog. et Trop. 7(1):53–58.

DOWNS, W. G., AITKEN, T. H. G., and ANDERSON, C. R. 1955. Activities of the Trinidad regional virus laboratory in 1953 and 1954 with special reference to the yellow fever outbreak in Trinidad, B. W. I. Amer. Jour. Trop. Med. and Hyg. Trans. 4(5):837–843, 8 refs.

FLOCH, H. 1955. Yellow fever control in French Guiana. The Caribbean 8(9):196–197, 208, 4 refs.

FLOCH, H., and FAURAN, P. 1954. Lutte antipaludique et lutte antiamarile en Guyane Française. Les moustiques vecteurs du virus de la fièvre jaune en Guyane Française. Inst. Pasteur Guyane Franc. Arch. 15, Pub. No. 322, 67 pp., 48 refs.

FREDERIKSEN, H. 1955. Historical evidence for interference between dengue and yellow fever. Amer. Jour. Trop. Med. and Hyg. 4(3):483–491, many refs.

GALINDO, P., and TRAPIDO, H. 1955. Forest canopy mosquitoes associated with the appearance of sylvan yellow fever in Costa Rica, 1951. Amer. Jour. Trop. Med. and Hyg. 4(3):543–549.

GILLETT, J. D., and ROSS, R. W. 1955. The laboratory transmission of yellow fever by *Aedes (Stegomyia) aegypti* (Linnaeus) from Malaya. Ann. Trop. Med. and Parasitol. 49(1):63–65.

LARTIGAUT and LARTIGAUT, D. 1954. Encephalite vaccinale du nourrisson apres vaccination contre la fièvre jaune. Jour. Med. de Bordeaux 131(12):1388.

MINISTERIO DE SALUBRIDAD DE CUBA. 1954. Fue Finlay y no Beauperthuy quien descubrió el mosquito como agente de transmissión de la fiebre amarilla. Inform. Cient. Nac. Bol. (Quito) 7(65):392–398.

PINTO SEVERO, O. 1955. La campana de erradicacion del *Aedes aegypti* en las Americas—su organization, evolution y resultados hasta Diciembre de 1954. Bol. Ofic. Sanit. Panamer. 38(4):378–398.

REID, J. A. 1954. A preliminary *Aedes aegypti* survey. Med. Jour. Malaya 9(2):161–168.

ROMERO, A. 1954. Fiebre amarilla en ninos memores de doce años. Rev. Biologia Trop. (San Jose, Costa Rica) 2(2):169–174.

———, and TREJOS, A. 1954. Clinica y laboratorio de la fiebre amarilla en Costa Rica. Rev. Biologia Trop. (San Jose, Costa Rica). 2(2):113–168, 10 refs.

STONES, P. B., and MACNAMARA, F. N. 1955. Encephalitis following neurotropic yellow fever vaccine administered by scarification in Nigeria, epidemiological and laboratory studies. Roy. Soc. Med. and Hyg. Trans. 49(2):176–186.

TAYLOR, R. M., HASEEB, M. A., and WORK, T. H. 1955. A regional reconnaissance on yellow fever in the Sudan; with special reference to primate hosts. World Health Organ. Bul. 12(5):711–725.

TRAPIDO, H., and GALINDO, P. 1955. The investigation of a sylvan yellow fever epizootic on the north coast of Honduras, 1954. Amer. Jour. Trop. Med. and Hyg. 4(4):665–674, 15 refs.

———, and CARPENTER, S. J. 1955. A survey of forest mosquitoes in relation to sylvan yellow fever in the Panama Isthmian area. Amer. Jour. Trop. Med. and Hyg. 4(3):525–542, 12 refs.

YELLOW FEVER CONFERENCE. 1955. Amer. Jour. Trop. Med. and Hyg. 4(4):571–661.

BIOGRAPHY AND HISTORY

COTRONEI, G. 1954. Lo spirito sciéntifico e l'opera parassitologica di Battista Grassi. Riv. di Parassitol. 15(4):177–189.

LA FACE, L. 1954. Gli studi entomologici di Battista Grassi. Riv. di Parassitol. 15(4):214–240.

RASHINA, M. G. 1954. E. L. Martsimovskii, organizre of control of malaria. Med. Parazit. i Parazit. (Moskva) 4:362–368. In Russian.

LITERATURE REFERENCES AND REVIEWS

BLOOMFIELD, A. L. 1955. Bibliography of internal medicine: malaria. Jour. Chron. Dis. 1(6):665–694.

SOLLERS, H. 1955. References to literature of interest to mosquito control workers and malariologists. *Mosquito News* 15(3):186–192.

SUBJECTS NOT COVERED BY OTHER HEADINGS

GEORGÉVITCH, J. 1954. Contribution à la connaissance de *Thelohania minor* nov. spec.

[Sporozoan] Acad. Serbe Sci., Classe Med. Sci. 11(2):25 31.

Guelmino, D. 1954. Diapause of *A. maculipennis* (var. *messae*, var. *typicus* and *A. bifurcatus*. Acad. Serbe Sci. Bul. Classe Sci Med. 11(2):50–52.

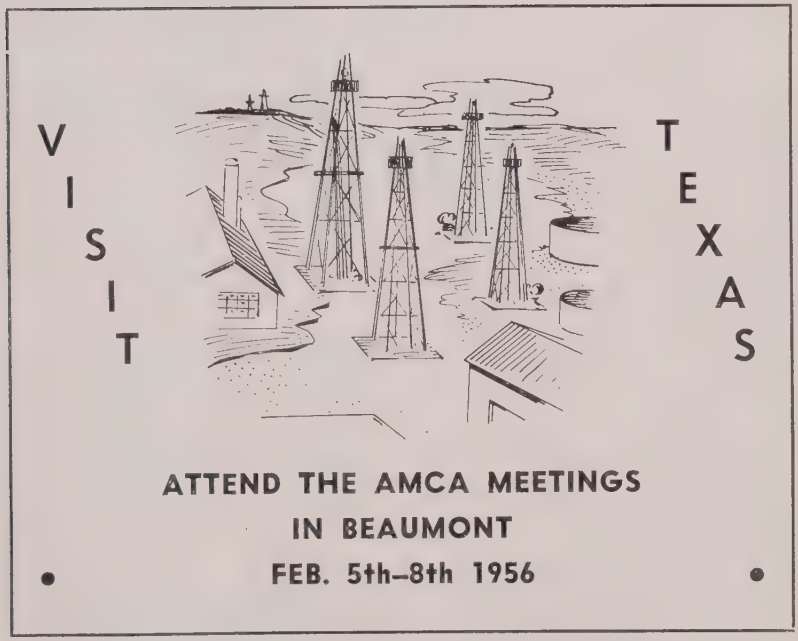
Lavrenko, E. M., Tishchenko, O. D., and Gandzii, N. A. 1955. Investigation on the degree and conditions of *Anopheles* infestations of reconstructed ponds. Med. Parazit. i Parazit. (Moskva) 24(1):18–19. In Russian.

Levi-Castillo, R. 1954. Estudios sobre *Culex pipiens quinque-fasciatus* en la ciudad de Guyaquil. Morfologia de los machos en razas resitentes y no resistentes a los insecticidas clorados, biometría ye technicsa usadas. Rev. Ecuatoriana Ent. y Parasitol. 2(1/2):7–13, refs.

Zakhar'iants, N. A. 1955. Data on fall phenology of *Anopheles maculipennis sacharovi* in Koland in Uzbekistan. Med. Parazit. i Parazit. (Moskva) 24(1):11–18. In Russian.

Erratum

In volume 15(3):191 of *Mosquito News*, section Malaria-Plasmodia, under Faure, A. change page 892 to read page 803.



FIRST . . . *and Best!*

TODD INSECTICIDAL FOG APPLICATOR

TIFA

Successfully Used for over 10 Years in Community Fly and Mosquito Programs

Tifa was first in the field of fog applicators. Tests have proved it best in the field for space control around the community . . . on the dump, over pools, in suburbs, everywhere insects swarm!

This amazing machine discharges newly-developed insecticides as well as the older types in a true, clean fog which spreads quickly and permeates the deepest crevices. This ability means a better insect control program for your community. Put Tifa to work for you!

EFFICIENCY FEATURES

Uses insecticides in solutions, emulsions or suspensions.

Produces penetrating fog, dry or wet as you wish.

Droplet Control ranges from ½ to 200 Microns.

Carrying Underwriters' Listing Seal

Write for illustrated folder with full details and official comments.

PRODUCTS DIVISION

TODD SHIPYARDS CORPORATION

HEADQUARTERS: Columbia & Halleck Streets, Brooklyn 31, N. Y.
PLANT: Green's Bayou, Houston 15, Texas

INDEX TO VOLUME 15

Compiled by Austin W. Morrill, Jr.

Subject Index

Adult mosquito control, temporary, for outdoor assemblies, 32
Aedes
aegypti, effects of atmospheric pressure on flight (review), 246
atropalpus, control in rock pools, with DDT-plaster of paris bricks, 240
melanimon, resurrection of species as separate from *dorsalis,* 170
sollicitans, in Kentucky, 42
taeniorhynchus, non-blood feeding, Sanibel Is., Fla., 21
Aedes spp., Alaskan, mermythid parasites of (note), 53, 125
eggs, preparation of chorion for microscopy, 228
oviposition site preference in laboratory, 224
Aerosol generators, portable, jet, for adult mosquito control, 1
Airplane spraying, with L–20, by U. S. Air Force, 73
Alaska, swarms of "woods mosquitoes" in McKinley Park, 173
Annual Meeting (11th), news of the Association, 103
Anopheles
darlingi, in Brazil (abstract), 248
gambiae, maxillary index and biological races, 207
maculipennis, member of complex breeding in treeholes, France, 161
physiology & anatomy of heart (review), 130
Anophelines
Anopheles larvae, thoracic vesicles, 168
Resistance to chlorinated hydrocarbons in Greece, 67
Applicator, for adding chemicals to flowing water, 143
Aspirator, mechanical, dry cell battery, 28
Association Meetings
Los Angeles, 49, 103
Toledo, 51
Atmospheric pressure, effects on flight of *Aedes aegypti* (review), 246
Attractiveness to mosquitoes of human sweat and carbon dioxide, 80
Bibliography (See References to Literature)
Beckel, Wm. E., brief biography (News and Notes), 244
Beeton Edw. M., Obituary, 123
Black flies of Guatemala (review), 129
Boat, air-propelled, used in Utah abatement work, 193
Bohart, Richard M., brief biography (News and Notes), 244
Brazil, *Culex fatigans,* filariasis, *A. darlingi,* malaria (abstracts), 248–249
Cage equipment, for study of pathogen-infected mosquitoes, 43
California, control of larvae in pastures, water-soluble insecticides, 139
Canada, report on recent progress, 195
Canal Zone, *Culicoides furens,* at Ft. Kobbe, 13
Carbon dioxide, role of, in attractiveness of humans to mosquitoes, 80
Chorion, Aedine egg, preparation of for microscopy, 228
Clothing, color of, effect on mosquito attacks on man (abstract), 247
Committees of the Association, 1954, 121
Control, temporary, for outdoor assemblies, 32
Culex
erythrothorax, discovery of, in Texas, 235
fatigans, in Brazil (abstracts), 248–249
tarsalis, biological studies on, in Kansas (abstract), 246
Culex spp., control in underground drains with nicotine smoke, 240
larval stages, in irrigated lands, Nebraska, 157
in Iraq, taxonomy & biology (abstract), 249
Culicoides furens, at Ft. Kobbe, C. Z., 13
Culicoides spp., in New England, 153
Culiseta melanura, laboratory observations on, 18
Diptera, biting, in Panama, light trap survey, 90
Dy, Francisco, brief biography (News and Notes), 183, 240
Egg production, feeding adult mosquitoes on preserved blood for, 176
Filariasis, in Brazil (abstracts), 248–249
Florida, *Aedes taeniorhynchus,* non-blood feeding, 21
Fog generation, insecticidal, for military use, 85
Fogs and mists for adult mosquito control (Toledo Seminar), 131
Food, mechanism of distribution to midgut or diverticula (review), 130
France, member of *Anopheles maculipennis* complex breeding in treeholes, 161
Frohne, Wm. C., brief biography (News and Notes), 244
Gray, Harold F., honored at Los Angeles meeting, 47
Greece, resistance of anophelines to chlorinated hydrocarbons, 67
Gulf Coast, invasion of, by salt-marsh mosquitoes, 164
Gynandromorph, reported in *Culex tarsalis* (note), 124
Haemogogus argyromeris, in saline water, 179
equinus, oviposition of, in nature, 163
Hardy, Karl Dean, Obituary, 185
Heart, dipteran, physiology and anatomy (*A. maculipennis*) (review), 130

Honduras, sylvan yellow fever in Northern (abstract), 246
Insecticides, granulated, against *Mansonia* larvae, 204
systemic, against *Mansonia* larvae, 204
water-soluble, for control of larvae in Calif., 139
Iraq, national campaign against malaria (review), 247
taxonomy and biology of culicine larvae (review), 249
Irrigated areas, *Culex tarsalis* in Nebraska, larval stages, 157
Jeep mounted mist blower, 71
Kansas, biological studies on *Culex tarsalis* (abstract), 246
Keys, pictorial, to mosquitoes of medical importance
IX Australian region, 35
Panama, 95
Komp, Wm. H. W., Obituary, 245
L-20, as a vehicle for aerial dissemination of insecticides, 73
Light traps, dry cell battery operated, 28
three-year survey of biting diptera in Panama, 90
Malaria control, in Panama, horse-baited traps as an index, 39
in Brazil (abstracts), 248–249
in Iraq, national campaign (abstract), 247
Mansonia larvae, granulated and systemic insecticides against, 204
Mayfly control, 156
Mermythid parasites, of *Aedes* in Alaska (notes), 53, 125
Military use of fog generators, 85
Mississippi, rice fields, chemical control of mosquitoes in, 148
Mist blower, jeep mounted, 71
Mosquito bionomics and relation to disease (review), 129
larvae, rapid permanent mounts for, revised procedure, 147
simple mounting medium for, 45
rice fields, chemical control in Mississippi, 148
Mounting medium, simple, for larvae, 45
Mounting, permanent and rapid, revised procedures for, 147
Nebraska, *Culex tarsalis* in irrigated areas, larval stages, 157
New England, *Culicoides* of, 153
Nicotine smoke cans, use for *Culex* larvae in drains, 240
Northeastern Mosquito Control Association, founding (editorial), 46
(News and Notes), 56
Operation Mercy, 93
Oregon Mosquito Control Association, First Report, 55
Oviposition site preference, *Aedes,* in laboratory, 224
Oviposition studies on *Haemogogus equinus* in nature, 163
Panama, biting diptera, light trap survey, 90
Pathogenic agents, cage equipment for study of mosquitoes infected with, 43
Peters, Richard F., brief biography (News and Notes), 184
Pictorial Keys (see Keys)
Plaster of paris bricks, DDT impregnated, for control of *Aedes* in rock pools, 240
Pletsch, Don J., brief biography (News and Notes), 244
Predators, of mosquito larvae and pupae, use of radioactive tracers with, (review), 248
Preserved blood, feeding adult mosquitoes on, for egg production, 176
Radioactive tracers, use in studies of predators of mosquitoes (review), 248
Rahim, Abdul, brief biography (News and Notes), 54
Resistance of anophelines to chlorinated insecticides in Greece, 67
Reviews and Abstracts (see Reviews of Literature), 129, 246
Rice field mosquitoes, chemical control in Mississippi, 148
Russell, Paul, brief biography (News and Notes), 183
REFERENCES TO LITERATURE, of interest in mosquito control and malariology
Adulticides, 58, 132, 250
Aerial application, 58, 186
Aerosols, 58, 132
Attractants, 133, 186
Behavior, 61, 134, 187, 251
Biology and ecology, 60, 133, 187, 251
Biography and history 256
Chemicals, 59, 187, 251
Control, 58, 132, 186, 250
Dengue, 62, 189
Diseases, 62, 135, 189, 253
Distribution, 61, 134, 188, 252
Ecology (See also 256–7), 61, 133, 187, 251
Encephalitis, 189, 135, 253
Equipment, 59, 133, 187, 251
Filariasis, 62, 136, 189, 253
Insecticides, 59, 187, 251
Larvicides, 58, 132, 186, 250
Literature reviews, 65, 138, 192, 256
Malaria, 62, 136, 190, 253
Morphology, 61, 134, 188, 252
Other subjects, 65, 138, 256
Parasites, 59
Physiology, 61, 134, 188
Predators, 59
Repellents, 59, 133, 186
Resistance, 59, 133, 186, 251
Taxonomy, 60, 135, 188, 252
Technique, 60, 134, 189, 252
Toxicology, 251
Yellow fever, 65, 138, 192, 256
Salivary glands, methods for dissecting in larvae & pupae, 73
Salt marsh mosquitoes, invasion of the Gulf Coast, 164
Salt marsh topography, influence on tidal action, 231
Slides, rack for staining one hundred, 26

Smoke cans, nicotine, for control of *Culex* in drains, 240
Solvents for fog formulations, 85
Staining of slides, rack for one hundred slides, 26
Sweat, human, attractiveness to mosquitoes, 80
Taiwan, foreman and operators' manual for residual DDT spraying (review), 130
Texas, discovery of *Culex erythrothorax*, 235
Thailand, Northern, initial light trap operation in, 218
Thoracic vesicles, of *Anopheles* larvae, 168
Thurman, Ernestine, brief biography (News and Notes), 244
Tidal action, influence of salt marsh topography on, 231
Topography, salt marsh, influence on tidal action, 231
Traps, horse-baited, as index to malaria control in Panama, 39
light, dry cell battery operated, 28
initial operation in Thailand, 218
Tree-hole breeding, *Anopheles maculipennis*, in France, 161
Twinn, C. F., brief biography (News and Notes), 54
U. S. Air Force, use of L-20 airplane for spraying, 73
Utah, air propelled boat used in abatement work, 193
Vannote, Robert L., brief biography (News and Notes), 183
Vargas, Luis, brief biography (News and Notes) 54
Water, flowing, applicator for adding chemicals to, 143
Water-soluble insecticides, for control of larvae in California, 139
West, Allen S., brief biography (News and Notes), 184
"Woods" mosquitoes, swarms of, in McKinley Park, Alaska, 173
Yellow fever, sylvan, in Honduras (abstract), 246

Author Index

Baker, W. C., 32
Barnett, H. C., 43
Barr, A. R., 170, 246 (review)
Beckel, W. E., 224
Bickley, W. E., 248 (review)
Bidlingmayer, W. D., 231
Bishopp, F. C., 129 (review)
Blanton, F. S., 13, 39, 90 95
Bowen, C. V., 143
Brown A. W. A., 1, 80
Burton, G. J., 26, 147
Chamberlin, R. W., 18, 28
Chapman H. C., 204
Coher, E. I., 153
Collett, G. C., 193
Cook, D. R., 35
Craig, G. B., Jr., 228
Dimond, J. B., 176
Dixon, E. B., 42
DeLong, D. M., 176
Durkee, H. L. T., 247 (review), 249 (review)
Eads, R. B., 235
Edmunds, L. R., 157
Elmore, C. 148
Foote, R. H., 35
Fox, Jean W., 207
Fox, Richard M., 207
Frohne, W. C., 173
Gahan, J. B., 139, 143
Galindo, P., 90, 95, 246 (review)
Hedeen, R. A., 161
Haeger, J. S., 21
Hahl R. G., 85
Harmston, F. C., 235
Jamnback, H., 130 (review)
Jensen, D. V., 215
Johnson, D. R., 93, 131 (review)
Jones, G. P., 71
Keenan, C. M., 13, 39
Klock J. W. 231
Knierim, J. A., 176
Knutson, H., 153
Kohler, C. E., 26
Komp, W. H. W., 163, 179
Labrecque, G. C., 143
Lea, A. O., 176
Lieux, D. B., 156
Lividas, G., 67
Lotze, K. A., 85
Lungstrom, L., 246 (review)
Mathis, W., 148
Menzies, G. C., 235
Morrill, A. W., Jr., 85, 86
Morrison, P. E., 1,
Mulhern, T. D., 139
Mulrennan, J. A., 156
Nelson, D. B., 18, 28
Nowell, W. R., 73
Notananda, V., 45
Peyton, E. L., 39, 90, 95
Rachou, R. G., et al., 248–9 (abstracts)
Schoof, H. F., 32, 148
Sudia, W. D., 18
Thomas, E. G., 131 (review)
Thompson, G. A., 164
Thompson, R. P., 80
Thurman, D. C., Jr., 218
Thurman, E. B., 218
Trapido, H., 246 (abstract)
Twinn, C. R., 195
Wesley, C., Jr., 86
Wirth, W. W., 153

181
2 PC

COMMONWEALTH INST.
ENTOMOLOGY LIBRARY
- 3 MAY 1956
SERIAL U.S.A.146
SEPARATE